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Standard Guide for Evaluating Asbestos in Dust on Surfaces by Comparison Between Two Environments[1]

This standard is issued under the fixed designation D7390; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 There are multiple purposes for determining the loading of asbestos in dust on surfaces. Each particular purpose may require unique sampling strategies, analytical methods, and procedures for data interpretation. Procedures are provided to facilitate application of available methods for determining asbestos surface loadings and/or asbestos loadings in surface dust for comparison between two environments. At present, this guide addresses one application of the ASTM surface dust methods. It is anticipated that additional areas will be added in the future. It is not intended that the discussion of one application should limit use of the methods in other areas.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific warning statements, see 5.7.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D5755 Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Surface Loading

D5756 Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Mass Surface Loading

D6480 Test Method for Wipe Sampling of Surfaces, Indirect Preparation, and Analysis for Asbestos Structure Number Surface Loading by Transmission Electron Microscopy

D6620 Practice for Asbestos Detection Limit Based on Counts

E105 Practice for Probability Sampling of Materials

E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process

E456 Terminology Relating to Quality and Statistics

E2356 Practice for Comprehensive Building Asbestos Surveys

2.2 *Other Document:*

Environmental Protection Agency, U.S. (EPA), (Pink Book) Asbestos in Buildings: Simplified Sampling Scheme for Surfacing Materials, EPA 560/5/85/030A, U.S. Environmental Protection Agency, Washington, DC, 1985[3]

3. Terminology

3.1 *Definitions*—Unless otherwise noted all statistical terms are as defined in Terminology E456.

3.1.1 *activity generated aerosol*—a dispersion of particles in air that have become airborne due to physical disturbances such as human activity, sweeping, airflow, etc.

3.1.2 *background samples*—samples taken from surfaces that are considered to have concentrations of asbestos in surface dust that are representative of conditions that exist in an environment that is affected by only prevailing conditions and has not experienced events, disturbances or activities unusual for the environment.

3.1.3 *control*—an area that is used as the basis for a comparison. This could be an area where the dust has been previously characterized, an area thought to be suitable for occupancy, an area that has not experienced a disturbance of asbestos-containing materials, or that is for some other reason deemed to be suitable as the basis for a comparison.

3.1.4 *control samples*—samples collected for comparison to the study samples. These differ from background samples in that they are collected: either: in an area where the dust has been previously characterized, or in an area that has not experienced a disturbance of asbestos-containing materials, or

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from United States Environmental Protection Agency (EPA), Ariel Rios Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460, http://www.epa.gov.

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in an area that is for some other reason deemed to be suitable as the basis for comparison.

3.1.5 *dust*—any material composed of particles in a size range of <1 mm.

3.1.6 *environment*—well defined three-dimensional area and everything that is in it.

3.1.7 *homogeneous samples*—group of samples that are collected from surfaces that are visually similar in texture, dust loading and environment.

3.1.8 *laboratory blank*—a cassette or wipe taken from laboratory stock that are not affected by field activities.

3.1.9 *loading*—quantity of asbestos in the dust found on a surface as measured by the ASTM standard methods for evaluating asbestos in dust on surfaces.

3.1.10 *open field blank*—cassette or wipe opened in the field as if for sample collection and then immediately closed. This blank is analyzed in the same manner as a regular sample.

3.1.11 *power*—power of the test is the probability, expressed as a decimal fraction, that a specified difference between asbestos surface loadings in two environments will be detected by the test.

3.1.12 *replicates*—samples collected from an area that is visually identified as homogeneous.

3.1.13 *sampling set*—samples collected on the same day on surfaces in an area for the purpose of characterizing the asbestos loading in the dust of the samples surfaces in that area.

3.1.14 *sealed field blank*—cassette or wipe taken to the field but remaining closed at all times.

3.1.15 *study samples*—samples collected in an area believed to have experienced events, disturbances or activities affecting asbestos-containing materials. The area in which these samples are taken is called the study area. Study samples are compared to background samples or control samples.

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4. Summary of Guide

4.1 The guidance contained in this document was developed for applications of Test Methods D5755, D5756, and D6480. The application addressed in this document is sampling to test for differences in surface loading in two or more environments including comparison to environments that may be considered to be "background."

4.2 Factors affecting the selection of sampling sites and types of samples to be collected are described in Appendix X1. These factors include:

4.2.1 Uniformity and distribution of dust within a building,

4.2.2 The nature of dust found within buildings,

4.2.3 The nature of the surface from which samples are to be collected,

4.2.4 Past disturbances of asbestos-containing materials,

4.2.5 Environmental conditions,

4.2.6 Ventilation,

4.2.7 Building history,

4.2.8 Occupation and activity of occupants, and

4.2.9 Outdoor sampling.

4.3 This guide describes statistical procedures to be used for:

4.3.1 Defining sampling needs including the size, number and location of samples required to address a particular application; and

4.3.2 Interpreting analytical results—estimating loadings or loadings from single or multiple-sample results, establishing confidence intervals for such estimates, and comparing between such estimates.

5. Significance and Use

5.1 This guide describes factors to be considered by an investigator designing a sampling program to compare the asbestos dust loadings in two environments and presents statistical methods for making the comparison. Each user is responsible for the design of an investigation and the interpretation of data collected when using dust data.

5.2 This guide does not deal with situations where dusts of different compositions or from different surfaces are to be evaluated.

5.3 This guide describes methods for interpreting the results of sampling and analysis performed in accordance with Test Methods D5755, D5756, and D6480. It may be appropriate to use the procedures in this Guide with other dust collection and analysis methods, but it is the responsibility of the user to make this determination.

5.4 The methods described in this guide are not intended to be used alone. They are intended to be used along with various evaluation methods that may include consideration of building use, activities within the building, air sampling, asbestos surveys (refer to Practice E2356), evaluation of building history and study of building ventilation systems.

5.5 This guide describes methods for comparing environments and does not draw any conclusions relating asbestos surface loadings to the potential safety or habitability of buildings.

5.6 This guide does not address risk assessments or the use of dust sampling in risk assessment. Health based risk assessments are beyond the scope of this guide.

5.7 **Warning—**Asbestos fibers are acknowledged carcinogens. Breathing asbestos fibers can result in disease of the lungs including asbestosis, lung cancer, and mesothelioma. Precautions should be taken to avoid creating and breathing airborne asbestos particles when sampling and analyzing materials suspected of containing asbestos. Regulatory requirements addressing asbestos are defined by USEPA[4,5] and OSHA[6].

6. Comparison Between Environments

6.1 One use of dust sampling is to compare the asbestos dust loadings on surfaces in two environments. This Guide describes two ways in which such a comparison might be made.

[4] USEPA, 40 CFR Part 61, Subpart M.
[5] USEPA, 40 CFR Part 763, Subpart E.
[6] OSHA, 29 CFR Parts 1910, 1915, and 1926.

6.1.1 *Comparison to Background Samples*—If one environment is considered to represent conditions that are typical of a building this could be used as the source of background samples against which study samples from areas in questions could be compared. Areas may be in question due to disturbance of an asbestos-containing material, damage to the building materials, change in occupancy or any other occurrence that could change the asbestos loading in dust.

6.1.2 *Comparison to Control*—One environment may be taken as a "Control" against which to compare study samples from other environments. For example, samples collected in a building to which cleaned items are to be delivered might be used as control samples. Samples collected on cleaned items would then be compared to these Control samples to determine if the cleaned items could be released for delivery.

6.2 *Sample Collection Requirements:*

6.2.1 *Homogeneous Dust*—A visual determination should be made about the homogeneity of the dust and sample site to be sampled. Samples in each environment should be collected from homogeneous locations. A location is considered to be homogeneous if:

6.2.1.1 The sample sites have visually similar depositions of dust on their surfaces.

6.2.1.2 The surfaces to be sampled have the same type of surface texture based upon a visual determination.

6.2.1.3 The efficiency of dust collection on a given surface is likely to be different for wipe and microvacuum methods (see Crankshaw et al, Ref (**1**)).[7] As such, the same sample collection method should be used for samples that are to be compared.

NOTE 1—If the laboratory reports comparing two areas indicate that the analytical sensitivities, particle sizes or structure types for any sample or a group of samples differ greatly from the balance of the samples, then this could indicate that the dust in the areas selected was not homogeneous. In these instances other methods of comparison may be considered.

6.3 *Selection of Sampling Locations:*

6.3.1 *Random Sampling*—Samples should be collected from locations that are selected at random from all available locations in the environment to be tested. Genuinely random procedure such as the grid and random number procedure set forth in the USEPA Pink Book, coin tosses, or a random number table are acceptable for this purpose.

6.3.1.1 In situations in which accessibility for sampling is limited the general location of samples should be determined by random means and the specific sample site determined by accessibility within the randomly selected area. The dust at the specific sampling site should be visually evaluated to determine if it is representative of conditions prevailing in the environment.

6.4 A sufficient number of samples need to be collected to be able to discern differences that may exist between the environments. The Annex describes methods for determining the number of samples necessary to accomplish this goal. The number of samples required depends, in part, upon the sensitivity of the analysis. As this sensitivity will not be known until the analysis is complete it is prudent to collect additional samples in case the sensitivity of actual samples does not match preliminary estimates used in planning the sampling.

6.5 *Sampling and Analytical Requirements:*

6.5.1 Collect and analyze samples as described in Test Methods D5755, D5756, or D6480.

6.6 *Quality Control Requirements:*

6.6.1 *Blanks*—The following blanks should be collected as part of the sampling:

6.6.1.1 A sealed field blank per lot of cassettes or wipes.

6.6.1.2 One open field blank for each ten samples (a minimum of one open field blank per environment sampled).

6.6.1.3 Blanks should be sent to the laboratory for analysis in the same manner as a regular sample. Blanks need not be analyzed if no asbestos is found in the study samples. If asbestos is found in the study samples the "Open Field Blanks" should be analyzed. If asbestos is found on the "Open Field Blanks," then the "Sealed Field Blanks" should be analyzed. If no asbestos is found on the "Open Field Blank" there is no need to analyze the sealed blanks. If any blank is found to contain more than the limit set forth in the section on blanks in the appropriate method then the sampling may be considered to be suspect.

6.7 *Data Interpretation:*

6.7.1 For each sample the number of asbestos structures counted, analytical sensitivity of the analysis, and asbestos loading should be extracted from the laboratory reports. The upper and lower 95 % confidence limits should be calculated using the procedures in Annex A1. Refer to Note 1 in 6.2.1.3 regarding analytical sensitivity.

6.7.1.1 For each group of samples for an environment the procedures of Annex A1 should be applied to the data in 6.7.1 to calculate the total asbestos structures counted, sum of sensitivity weights, and estimate of asbestos loading for the environment along with upper and lower 95 % confidence limits on this estimate.

6.7.2 There are two ways to make a decision about whether there is a difference between two areas. The first of these is to simply compare the confidence limits of the two sets of samples. If this comparison shows that the two sets of samples are clearly the same, or are clearly different then no further comparison is required. However, if there is a question about the comparison of the confidence limits or this comparison is inconclusive a Z-test may clarify the issue.

6.7.2.1 If the confidence limits of the sample sets from two homogeneous areas overlap then the two areas can be considered to have the same asbestos loading in the dust on the sampled surfaces. If the confidence limits do not overlap then the asbestos loadings are different. Confidence limits are considered to be overlapped if the upper confidence limit of group of samples with the lower estimated mean exceeds the lower confidence limit of the group of samples with the higher estimated mean. This simple test may be augmented with other statistical tests to confirm the conclusion. This is particularly appropriate if the overlap or separation of the confidence intervals is small. Refer to Annex A1 for more information on the use of confidence limit comparison.

[7] The boldface numbers in parentheses refer to the list of references at the end of this standard.

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6.7.2.2 Another way of making a comparison is with the Z-test. Annex A1 describes a statistical test using a normal distribution approximation and a Z-test.

6.7.2.3 If the statistical tests in 6.7.2.1 and 6.7.2.2 give conflicting results then it is recommended that additional samples be collected to clarify the situation.

6.7.3 Consideration of the mineral form of the asbestos found during analysis of settled dust samples may help with interpretation of the data. If the mineral form of the asbestos in the two sets of samples (study samples and control or background samples) is different, the sites cannot be considered equivalent in terms of dust loadings and additional investigation may be necessary.

NOTE 2—If the size or type of asbestos structures differs between the study samples and control or background samples this also may indicate a difference in the dust loadings at each site. For example, if one set of samples consists of small fibers and the other set has large matrices, then these areas would appear to be different. As such, additional investigation may be necessary in such an instance, even if statistical analysis of the number or mass of particles finds no difference between the sites.

6.8 *Reporting:*

6.8.1 The report should contain sufficient information to allow the reader to locate the sampling sites, and repeat the sampling.

6.8.2 The complete data set should be reported, including results of blanks and background samples.

6.8.2.1 For each sample the number of asbestos structures, analytical sensitivity, asbestos loading and upper and lower 95 % confidence limits on the asbestos loading should be tabulated.

6.8.2.2 For each group of samples for a homogeneous environment the total asbestos structures counted, sum of sensitivity weights, and estimate of asbestos loading for the environment along with upper and lower 95 % confidence limits on this estimate should be reported.

6.8.2.3 The type of statistical comparisons and results of these comparisons should be given.

6.8.3 Laboratory reports should be included as an appendix to the report.

6.9 *Example 1*—The following example illustrates application of the procedures described in this guide.

6.9.1 *Situation*—An uncarpeted 20 by 20-ft storage room that has a visible layer of dust which is suspected to have come from known asbestos-containing material in the room. This area is designated as the study area.

6.9.2 *Choice of Analytical Method*—Any of the ASTM asbestos dust sampling methods could be used for this example. For the sake of illustration it is assumed that the investigator chose to use structure number loading from microvacuum collection (Test Method D5755) due to familiarity with this method.

6.9.3 In this example a background area in the same facility was chosen that matched the study area closely in its configuration, construction, use, and occupancy. This included type of surface area. The chosen area was in the same portion of the facility as the study area so it shared a common history, but was remote enough that it would not have been affected by a disturbance in the study area. Generally a study area will be selected that is considered to be acceptable for occupancy.

6.9.4 *Determination of Sample Number*—The table in A1.8.2 was used to determine the number of samples to be collected in each environment. The surfaces were relatively clean so it was assumed that the analytical sensitivity of the analysis would be no greater than 2000 s/cm^2. It was hypothesized that the loading in the study area would be about 5000 and in the background area would be around 1000 s/cm^2. The same number of samples will be collected in each area. For these conditions the table indicates that 5 samples will be needed in each area.

6.9.5 *Selection of Sampling Locations*—Both the study and background area contained bookshelves. There was visible dust on the shelves in the study area that was thought to have come from the disturbance of ACM. The book shelves in both locations were constructed of painted wood and as such are expected to have similar sample collection characteristics. The bookshelves were selected as the sample location.

6.9.5.1 Each individual shelf was given an identification number. Five shelves in each location were selected by use of a random number table. Samples were collected prior to routine cleaning of the study area.

6.9.6 *Quality Control*—In this example a sealed field blank was selected for the building, one field blank was taken for the study area, and one field blank was taken for the background area.

6.9.7 *Interpretation of Analytical Data*—Tables 1-3 give

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TABLE 1 Example 1—Hypothetical Dust Sample Results

Study Area						Background Area					
Number of Structures	Analytical Sensitivity (s/cm^2)	Sensitivity Weights	Result (s/cm^2)	95 % LCL (s/cm^2)	95 % UCL (s/cm^2)	Number of Structures	Analytical Sensitivity (s/cm^2)	Sensitivity Weights	Result (s/cm^2)	95 % LCL (s/cm^2)	95 % UCL (s/cm^2)
6	205.1	0.0049	1231	452	2679	4	205.1	0.0049	820	224	2101
4	205.1	0.0049	820	224	2101	5	205.1	0.0049	1026	333	2393
7	205.1	0.0049	1436	577	2958	6	205.1	0.0049	1231	452	2679
2	205.1	0.0049	410	50	1482	4	205.1	0.0049	820	224	2101
3	205.1	0.0049	615	127	1798	6	205.1	0.0049	1231	452	2679

where:
Number of Structures = The number of structures counted as contained in the report from the analysis.
Analytical Sensitivity = The concentration represented by a single count as contained in the report from the analysis.
Sensitivity Weight = The reciprocal of the analytical sensitivity (1/analytical sensitivity).
Result = The "analytical sensitivity" multiplied by the "number of structures." This should equal the result reported by the analytical method.
95 % LCL = The lower 95 % confidence limit as calculated using the formulas in the Annex.
95 % UCL = The upper 95 % confidence limit as calculated using the formulas in the Annex.

TABLE 2 Hypothetical Laboratory Parameters

Effective filter area (EFA)	923 mm^2
Number of grid openings examined (GO)	10
Average grid opening area (GOA)	0.009 mm^2
Sample area (SPL)	100 cm^2
Total Volume	100 mL
Volume filtered (V)	50 mL
Calculated Analytical Sensitivity	205.1 s/cm^2

TABLE 3 Example 1—Comparison of Spaces—Combine Measurements in a Weighted Average

Study Area						Background Area					
Total Structures	Weighted Analytical Sensitivity (s/cm^2)	Sum of Sensitivity Weights	Estimate (s/cm^2)	95 % LCL (s/cm^2)	95 % UCL (s/cm^2)	Total Structures	Weighted Analytical Sensitivity (s/cm^2)	Sum of Sensitivity Weights	Estimate (s/cm^2)	95 % LCL (s/cm^2)	95 % UCL (s/cm^2)
22	41.0	0.024	902	566	1366	25	41.0	0.024	1026	664	1514

data from a hypothetical laboratory report and the calculations of the upper and lower 95 % confidence limits as described in Annex A1.

6.9.7.1 In Table 3 the measurements are combined into a weighted average as described in Annex A1. As described in 6.7.2.1 the confidence limits of the study area are compared to the confidence limits for the background area. The confidence limit of the samples for the study area and the background area overlap indicating, as described in 6.7.2.1, that there is no statistical difference between the areas.

6.9.7.2 Inspection of the data in Table 3 finds that there is substantial overlap between the confidence limits for the study area and background area. It is decided that no further statistical testing in necessary.

(1) Example 1 is based on the hypothetical laboratory parameters (see Table 2) as would be found in reports from Test Methods D5755, D5756, and D6480. These parameters are typical for a nominal analytical sensitivity equal to 200 s/cm^2.

(2) To compare these two environments the sensitivity weights of the individual measurements are added together and a "Weighted Analytical Sensitivity" is calculated by taking the reciprocal of the "Sum of Sensitivity Weights." The "Estimate" of the concentration in each space is calculated by multiplying the "Weighted Analytical Sensitivity" by the "Total Structures" counted in the space. The 95 % upper and lower confidence limits for this estimate are calculated in the same manner as was used for the individual measurements.

Note—Refer to Practice D6620 for information on dealing with situations where there are zero structure counts.

(3) As can be seen by inspection of Table 3 the confidence limits for the study area and the background area overlap. As such there is not a statistically significant difference between the asbestos loadings in the two locations.

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6.10 *Example 2*—Table 4 presents hypothetical results for the same situation described in Example 1 but where there was a need to perform serial dilutions during the analysis resulting in higher value for the analytical sensitivity for two of the samples from the study area. This affects the spread of the confidence limits resulting in broader confidence limits for the study area. As with example 1 the calculation procedures from Annex A1 have been applied. The laboratory parameters for this set of evaluations are given in Table 5.

6.10.1 Comparison of the 95 % confidence limits in Table 6 finds that there is an overlap of the confidence intervals. The simple confidence limit test of 6.7.2 thus indicates that there is no statistical difference between the two environments. This is despite the fact that the estimated asbestos loadings in the two

TABLE 4 Example 2—Hypothetical Dust Sample Results

Study Area						Background Area					
Number of Structures	Analytical Sensitivity (s/cm^2)	Sensitivity Weights	Result (s/cm^2)	95 % LCL (s/cm^2)	95 % UCL (s/cm^2)	Number of Structures	Analytical Sensitivity (s/cm^2)	Sensitivity Weights	Result (s/cm^2)	95 % LCL (s/cm^2)	95 % UCL (s/cm^2)
2	205.1	0.0049	410	50	1482	15	205.1	0.0049	3077	1722	5074
6	205.1	0.0049	1231	452	2679	19	205.1	0.0049	3897	2346	6086
15	205.1	0.0049	3077	1722	5074	2	205.1	0.0049	410	50	1482
10	10 255.6	0.0001	102 556	49 179	188 603	10	205.1	0.0049	2051	984	3772
19	10 255.6	0.0001	194 856	117 316	304 291	6	205.1	0.0049	1231	452	2679

where:
Number of Structures = The number of structures counted as contained in the report from the analysis.
Analytical Sensitivity = The concentration represented by a single count as contained in the report from the analysis.
Sensitivity Weight = The reciprocal of the analytical sensitivity (1/analytical sensitivity).
Result = The "analytical sensitivity" multiplied by the "number of structures." This should equal the result reported by the analytical method.
95 % LCL = The lower 95 % confidence limit as calculated using the formulas in the Annex.
95 % UCL = The upper 95 % confidence limit as calculated using the formulas in the Annex.

TABLE 5 Hypothetical Laboratory Parameters

Laboratory Parameters for 0.5 of Total Volume		Laboratory Parameter for Dilution to 0.01 of Total Volume	
Effective filter area (EFA)	923 mm^2	Effective filter area (EFA)	923 mm^2
Number of grid openings examined (GO)	10	Number of grid openings examined (GO)	10
Average grid opening area (GOA)	0.009 mm^2	Average grid opening area (GOA)	0.009 mm^2
Sample area (SPL)	100 cm^2	Sample area (SPL)	100 cm^2
Total Volume	100 mL	Total Volume	100 mL
Volume filtered (V)	50 mL	Volume filtered (V)	1 mL
Calculated Analytical Sensitivity	205.1 s/cm^2	Calculated Analytical Sensitivity	10 255.6 s/cm^2

TABLE 6 Example 2—Comparison of Spaces

Study Area						Background Area					
Total Structures	Weighted Analytical Sensitivity (s/cm^2)	Sum of Sensitivity Weights	Estimate (s/cm^2)	95 % LCL (s/cm^2)	95 % UCL (s/cm^2)	Total Structures	Weighted Analytical Sensitivity (s/cm^2)	Sum of Sensitivity Weights	Estimate (s/cm^2)	95 % LCL (s/cm^2)	95 % UCL (s/cm^2)
52	67.5	0.015	3508	2620	4601	52	41.0	0.024	2133	1593	2797

TABLE 7 Example 2—Z-Test

NOTE 1—p-value ≤ 0.05 then the two populations are different.

Z	p-value	Statistical Difference
2.50	0.01	Yes

environments appear substantially different. The 3508 s/cm^2 in the Study Area appears higher than the 2133 s/cm^2 in the Background Area. Closer inspection of the data in Table 6 discovers that the overlap between the 95 % confidence limits is small. At 2796 s/cm^2 the 95 % UCL for the Background Area overlaps the 2620 s/cm^2 for the 95 % LCL for the Study Area by only 157 s/cm^2. It is decided that additional statistical testing using the Z-test is appropriate.

6.10.2 Application of the Z-test procedure described in A1.4.3 results in a Z of 2.5 and a p-value of <0.012 which indicates that there is a significant difference between the environments.

6.10.2.1 The p-value for the Z-statistic should be reported. The convention is to conclude that the levels in the two areas being compared are different if the p-value is 0.05 or less. The p-value is the probability of a Type I error (false positive outcome) and should be judged accordingly for decision-making based on the consequences of a Type I error, as interpreted by the individual conducting the test.

6.10.3 The conflict between the results of the two tests likely arises from the fact that the actual analytical sensitivities for samples from the study area exceed the 2,000 estimated when a determination was made about the number of samples required. Based on these results it is recommended that additional samples be collected to resolve the conflict. The number of additional samples can be calculated by using the equation in A1.8.1 of Annex A1.

6.10.3.1 The additional number of samples should be determined using the procedures described in A1.8 of the Annex using sensitivities that are equal to the average of the observed sensitivities in the initial sampling.

(1) Example 2 is based on the hypothetical laboratory parameters (see Table 5) as would be found in reports from Test Methods D5755, D5756, and D6480.

(2) To compare these two environments the sensitivity weights of the individual measurements are added together and a "Weighted Analytical Sensitivity " is calculated by taking the reciprocal of the "Sum of Sensitivity Weights." The "Estimate" of the concentration in each space is calculated by multiplying the "Weighted Analytical Sensitivity" by the "Total Structures" counted in the space. The 95 % upper and lower confidence limits for this estimate are calculated in the same manner as was used for the individual measurements. The results of these calculations are shown in Table 6.

(3) As can be seen by inspection of Table 6 the 95 % upper confidence limit of the background area (2797) is higher than the 95 % lower confidence limit of the study area (2620) indicating that there is not a statistically significant difference between the asbestos loadings in the two locations. However, the overlap is small.

(4) The Z-test calculations were performed as described in the Annex with the results given in Table 7.

7. Keywords

7.1 asbestos; indirect; mass; microvacuuming; settled dust; surface; TEM; wipe

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