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Mold Testing Scams

Addressing the d50 Issue

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In a recent thread on a Home Inspector's Facebook site, Mr. Brett Jones, a Home Inspector with Scott Homes Services[1] in Colorado, attempted to enter into a discussion by advocating for "mold testing" for spores in the air to support the common erroneous notion of comparing an indoor air sample result for mold with an outdoor air sample result for mold. Central to his argument was his rejection of the science behind the practical implications of the sampling characteristic of most spore traps known as the "cut value" (also called the d-50) of the device.

For people desiring to debate legitimate experts in any particular field, hastily running off to Google to search a new technical term one is not otherwise familiar with will rarely prove to be a successful strategy. Mr. Jones' comments (addressed directly at the end of this discussion) indicated a gross lack of understanding of the technical issues at hand, but more importantly, a lack of *insight*.

Similarly, Mr. Jones also demonstrates the problems one can encounter when citing references that one hasn't actually read, as was done by Mr. Jones. If Mr. Jones had actually read the documents from the organizations he references, he would have known that they do not support his position and they actually hold positions contrary to his desired position. In fact, had Mr. Jones read my posts before he criticized them, he also would have seen that I included many quotes from those organizations in my discussions.

Since the misconceptions that appear in Mr. Jones' comments are merely part and parcel of a larger error of believing that air sampling for mold, as it is commonly performed, has any validity or usefulness, I decided to address the issue as a stand alone discussion.

Insight

To come to a proper and rapid diagnosis, a good physician draws upon a very broad base of knowledge rather than relying on a multitude of highly speculative tests. A proficient physician appears to almost "instinctively" come to the proper diagnosis. But in reality, such a conclusion is often a "recognition" decision making process born from years of errors and missteps and an intimate knowledge of nuanced associations.[2] However, within this context we can innocently develop "bias," which is a conclusion based on a paradigm that may, in fact, be a questionable paradigm -This is what Thomas Kuhn has dubbed "normal science."[3] The ability to avoid bias

[1] https://scotthomeinspection.com/meet-the-team/

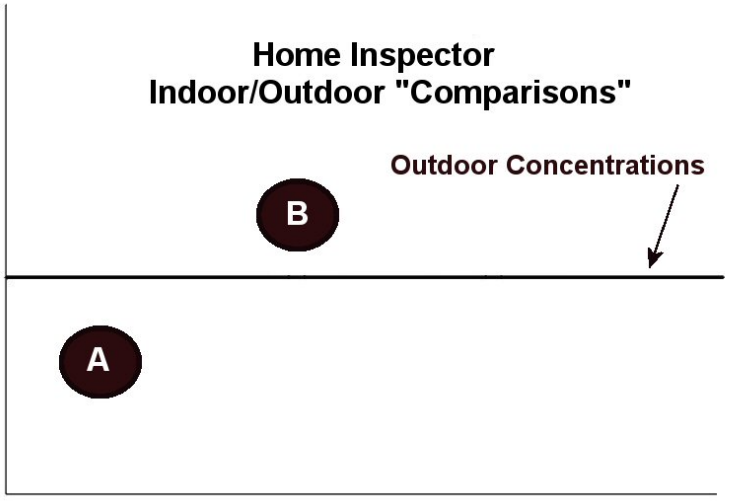
[2] Kahneman D, *Thinking, Fast and Slow*, Farrar, Straus and Giroux Pubs, 2013

[3] Kuhn T, *The Structure of Scientific Revolution*, University of Chicago Press, 1962

while still accumulating the minutia needed to develop a subconscious network of recognition (and possibly error) is the character of insight. In the Home Inspection and "Mold Inspection" industries false paradigms are the foundation of virtually all the "mold testing" that occurs.

In the real world, virtually all "mold testers" (especially the "certified" mold testers) lack training and insight in aerobiology, sampling theory and statistics and collect air samples and then falsely claim to their clients that they are comparing indoor spore concentrations to outdoor spore concentrations. The black circles in the graphic below represents how Home Inspectors and "certified" mold goobers compare indoor air samples to outdoor mold samples.

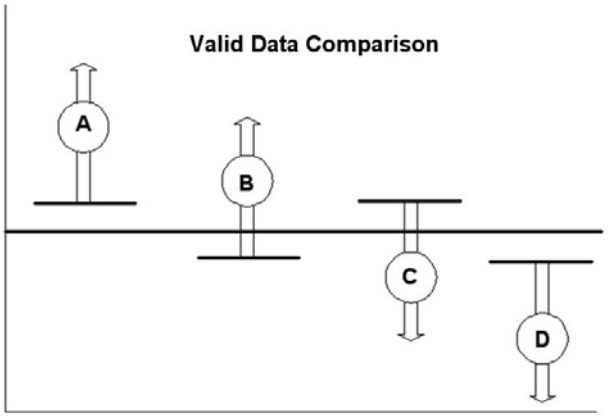
If the reported laboratory value for the indoor air spore concentration (black circle A), is below the lab-reported outdoor air spore concentration (horizontal black line), the Home Inspector tells the client the house is OK, and if the reported laboratory value for the indoor air spore concentration is greater than the lab-reported value for outdoor air, (black circle B), the Home Inspector tells the client the house has a mold problem.



However, all air sampling results exhibit "variability" (also known as "error.") The reported value (RV) provided by an analyzing laboratory is not the "absolute truth," but rather, it is a presumptive value wherein the real concentration from which the sample was collected has a probability to be somewhere greater than the reported value (called the Upper Confidence Limit, UCL) and a probability to be somewhere less than the RV (called the Lower Confidence Limit). (See the graphic below).

Because of this variability, when we are comparing air sampling data, for confidence, legitimate and knowledgeable investigators need to use the Confidence Limits of the data for comparison to our reference value.

Thus, if I am going to compare my air sampling exposure data from, say, a factory, against the OSHA permissible exposure limit, I cannot be fully confident that my data are less than the standard unless the Upper Confidence Limit (UCL) of my test data is below the reference standard (Scenario D, the graphic below). Similarly, OSHA may take the opposite approach, wherein they cannot be confident of an overexposure unless the Lower Confidence Limit (LCL) of the data set is greater than the standard (Scenario A, the graphic below). Scenarios B and C are responsibly regarded as "probable overexposures."



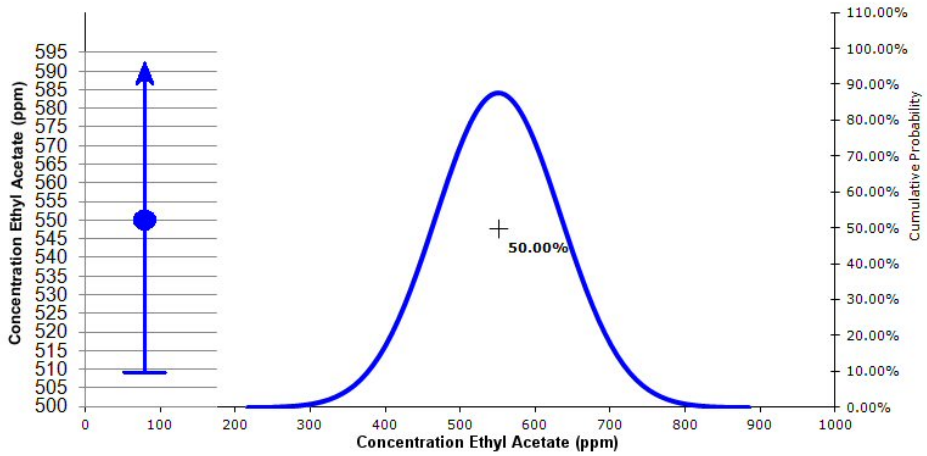
For legitimate air sampling protocols, information on the potential error is very often published and the investigator's ability to ensure they are reporting truthful and accurate information is greatly facilitated. For example, if we look at the NIOSH Method 0500[4] for total airborne dust we see the following:

BLANKS:	2 to 10 field blanks per set	ESTIMATED LOD:	0.03 mg per sample
BULK SAMPLE:	none required	PRECISION ($\bar{S}_r$):	0.026 [2]
ACCURACY			
RANGE STUDIED:	8 to 28 mg/m³		
BIAS:	0.01%		
OVERALL PRECISION ($\hat{S}_{rT}$):	0.056 [1]		
ACCURACY:	±11.04%		

[4] US National Institutes of Occupational Safety and Health *Manual of Analytical Methods* (NMAM), Fourth Edition, 1994

Using that information, the investigator can take the value from the laboratory report and begin to calculate the upper and lower confidence intervals to estimate the actual airborne dust exposures present when the sample was collected.

So, depending on the total error, a value reported by a laboratory in their report, for say, ethyl acetate, may be 550 parts per million (ppm), and the investigator then calculates the upper and lower confidence intervals:



As I will address below, air sampling for mold spores is very different. Air samples for mold are neither accurate, nor are they precise. Indeed, the air samples being collected by Home Inspectors are so incredibly inaccurate and so incredibly imprecise, that they are virtually useless.

But untrained consultants don't see those problems because people are profoundly bad at comparing two groups of values and we grossly underestimate the variability hidden in small sample groups. I'm going to give a recent example used by Dr. John Mulhausen[5] from one of his lectures to a group of Industrial Hygienists. Dr. Mulhausen gave his audience the following air sampling results of an imaginary compound with an OSHA exposure limit of 100 ppm:

[5] Mulhausen J, *Making Accurate Exposure Judgments: Critical for Effective and Efficient Risk Management*, ACGIH Lecture Series, December 17, 2025

38 ppm
68 ppm
12 ppm

And he asked the participants, without running the calculations, just by looking at the data set, if they believed the data indicate, with confidence, a low probability of an overexposure or a high probability of an overexposure. The majority of the group, (including me) intuitively believed the data indicated a low probability of an overexposure. We were all wrong. The geometric standard deviation of the data set is 2.4; the 95th percentile is 134 ppm. The UCL95 for 70% of the samples, is 375 ppm. Therefore, if thousands of samples were collected over time, 69% of the samples would exceed the permissible exposure limit. It is not only irresponsible to take and directly use values reported from a laboratory report, it is also not scientifically valid.

Usually, however, one doesn't need to be a statistical genius to immediately identify a serious problem in air sampling data for molds just by looking at it. Although most "air testing" companies only collect one or two or five samples, in a recent case wherein I testified, the "certified" mold goober collected an outdoor sample (whose result was 1,396 spores per cubic meter of air), and then he collected 16 indoor samples (each of the following were expressed as spores/m3):

927
967
186
823
213
720,130
683
227
1,167
27
850
80
20,320
250
303
93

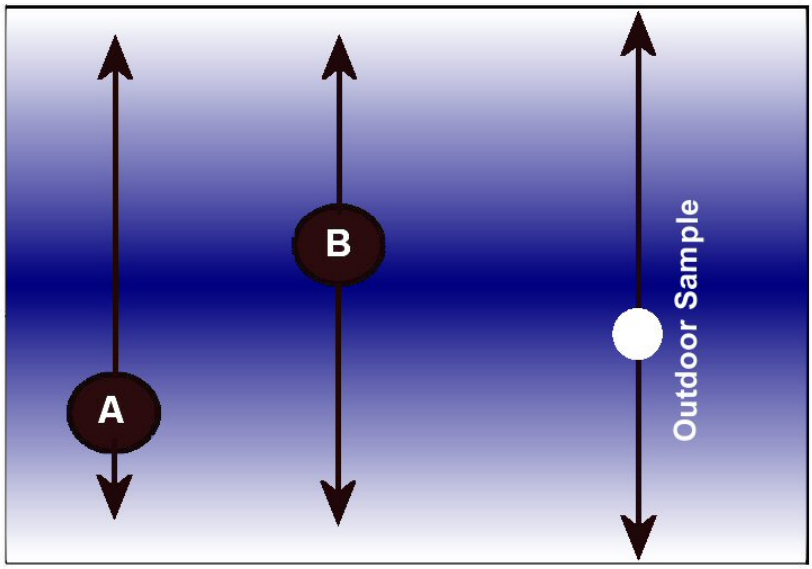
It should not, in my opinion, take a mathematical genius to look at that data set and notice that it is "all over the board" which should automatically raise the question "Which sample should I use to represent the indoor spore concentration?"[6] Clearly the data indicate (as expected) extremely high variability that is normally seen in typical mold air testing. But the "certified" mold goober in this case never performed a statistical analysis, never noticed the importance of the extreme variability and, remarkably, just concluded the indoor-to-outdoor air tests proved the house was horribly contaminated which was why they gutted the residence and threw out **EVERYTHING** in the house (including the outdoor barbeque set), all with the approval of a Certified Industrial Hygienist.

[6] I have addressed the problem of "representativeness" elsewhere.

Now, imagine that you plan on comparing the contaminant concentration of one environment against the concentration found in another environment to determine if one environment is higher than the other (say, comparing the airborne spore concentration inside a house with the airborne spore concentration outside the house).

Now, you have *two* moving targets – one is your test atmosphere (inside the house), and the other is your reference atmosphere (outside the house). So, now you have two sets of confidence intervals.

In this scenario, the investigator cannot be fully confident that there is a reasonably low probability the spore concentration in the house is lower than the outdoor air concentration unless the house UCL is less than the outdoor air LCL. Similarly, one cannot be confident that the house air is higher than the outdoor air unless the house LCL is greater than the outdoor air UCL. Everything between those limits would be "inconclusive." So that looks like this:



Since all such people who are claiming they are performing indoor/outdoor comparisons are only collecting one (or two or three or four) samples from the inside of the house, and virtually always only one sample from the outside of the house, the variation associated with all of the samples is on the same order of magnitude, making such comparisons impossible. Now, sample A is indistinguishable from sample B and neither sample can be said to be greater than or less than the outdoor air.

ERROR

So what is error?

Home Inspector, Mr. Jones, who defended making such comparisons in spite of the huge variabilities associated with such samples referenced the ACGIH, claiming they said the comparisons are valid. Let's take a peek at what the ACGIH actually states:[7]

[7] Macher JM, *Data Analysis: Chapter 13 Bioaerosols Assessment and Control* 1st. Ed

Ideally, measurements of airborne biological agents should be accurate and precise, that is, **correct** *(or close to the truth) and repeatable or reproducible. NIOSH has defined a laboratory method as accurate if 95% of the time it provides a result that is within 25% of the correct value (±25%) (i.e. not less than 25% below or more than 25% above the true value). Measurement error is the deviation of a given measurement from the true value and is composed of chance error (random or sampling error) and bias (systematic or non-sampling error). Replicate samples or repeated analysis of samples are used to assess the former. The SD of a series of replicate measurements or repeated analysis estimates the magnitude of chance error in a single measurement. Bias is a systematic tendency for an estimate to be too high or too low. Comparison with an external standard or reference is needed to detect bias. A sample may be considered representative if it is reasonably accurate and unbiased. Readers should note that the discussion in this section has considered just the variability of individual measurements from the truth, not the variability of the concentration of a biological agent over time or within a space.*

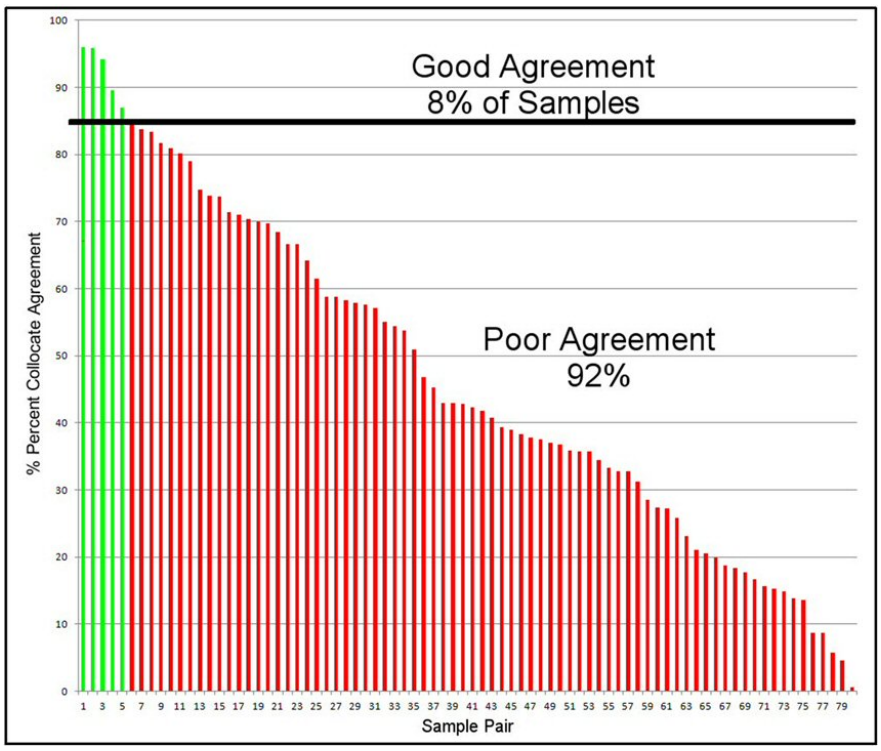
Error, as I use it in this discussion, also means drawing a conclusion, within a paradigm, from a set of observations that do not conform with reality. Often errors are innocent and are the result of ignorance. Sometimes errors are reckless and ignored in order to protect a very profitable and thus cherished (but false) paradigm (such as pretending, as Mr. Jones does, that one can compare indoor spore concentration with outdoor spore concentrations, even when one hasn't actually measured the spore concentration but is only comparing reported values on a laboratory report).

What we see with most valid air sampling and analyses is that the errors are sufficiently small, or sufficiently characterized to allow the data to be used with confidence- or, as cited in the Macher quote from above, "correct." However, in my experience, Home Inspectors and others who are performing "mold testing" **NEVER** collect samples in proper manner that would allow them to estimate the actual spore concentrations in the study areas, and their methods are entirely incapable of meeting the ±25% as specified in the referenced ACGIH document.[8] In fact, the training and the "mold testing" methods employed by Home Inspectors and "certified" mold inspectors are so incredibly bad, mold assessment reports from these consultants are 100% incorrect, 100% of the time.[9] In fact, the methods used by Home Inspectors and "certified" mold inspectors is so amazingly bad, that if they were to take two identical air samples at exactly the same time in exactly the same room, and the two samples were side-by-side and separated by only one foot, they would only get good agreement (i.e. ±25%) between the collocated samples 15% of the time. That is, 85% of the time, the two samples would not even agree with each other at the 25% threshold.[10]

[8] Robertson LD, et al, *A multi-laboratory comparative study of spore trap analyses* Mycologia, 103(1), 2011, pp. 226–231. DOI: 10.3852/10-017

[9] In almost 40 years of reviewing "mold testing" reports, I never encountered a single report, where the testing has been performed correctly, and judging by the push back I receive from Home Inspectors who perform the bogus sampling, they adamantly defend the non-scientific and unsupportable manner in which they try to use their air sampling data.

[10] Connell CP, *Sampling Strategies and Data Interpretation*, original paper presented at Churchill College, Cambridge University, England, May 2016



Comparison of Side-by-side
Spore trap results

The relative uncertainty of a concentration measurement can be estimated from the sum of the squares of each variable relative uncertainty.[11]

$$\frac{\omega_c}{C} = \left[\left(\frac{\omega_a}{a}\right)^2 + \left(\frac{\omega_b}{b}\right)^2 + \left(\frac{\omega_d}{d}\right)^2 + \left(\frac{\omega_e}{e}\right)^2 \ldots etc\right]^{1/2}$$

Here, "ω_a" would be just the analytical error by itself – which, just by the way, is itself so huge but also is actually the compound of multiple errors within it. Thus,

$$E_{analysis} = [E_1^2 + E_2^2 + E_3^2 + E_4^2 \ldots E_n^2]^{1/2}$$

E_1 – Would be the uncertainty in the number of spores counted
E_2 – Would be the uncertainty in whether the item counted was actually a spore
E_3 – Would be the uncertainty produced by the fraction of the trace analyzed
E_n – and so forth

Overall then the error would be:

[11] Marcham CL, *Lab & Data Sample Analysis/Interpretation*, ACGIH Bioaerosols Lecture Series, 2025

ω_b would be the spatial error
ω_d would be the temporal error
ω_e would be the error of capture efficiency (the error induced by the d-50)… and so forth for the entire chain of errors.

According to the ACGIH and the AIHA, and NIOSH and the EPA people who perform "mold testing" should attempt to assess the uncertainties related to all other aspects of bioaerosol sampling[12] including the error associated with the actual analysis (which is huge), sample collection time (small error), collection efficiency based on the d-50 (which is a huge error) for the targeted particle sizes, spatial errors (which are huge), temporal errors (which are huge).

Home Inspectors and "certified" mold goobers who are performing "mold testing" **NEVER** consider **ANY** of these errors,[13] and never report valid spore concentrations in their reports and never perform valid indoor-outdoor comparisons.

Cut Value

This discussion is about an operational parameter of spore traps called the "cut-value" (also known as "cut-size" and "d-50") and which constitutes one of the very large errors associated with mold air samples.

But when considering the errors associated with the cut-value characteristic of spore traps, one should remember that although the error produced by the d-50 characteristic is so large that, just by itself, it can completely invalidate a consultants conclusion's when looking at a lab report, but it is only one link of the chain of huge errors that conspire to compound each other into an overall error that is so large that just one sample (or even two or three from each area) is rendered completely invalid, uninterpretable, and useless. Using such air sample results without incorporating (or even understanding) these limitation is, in my opinion, both reckless, and irresponsible, and merely underscores the investigator's technical incompetence and their unethical practices (or even criminal fraud).

Unbeknownst to Home Inspectors who use spore-traps, these devices have a specific and known "cut-size" associated with the sampler. The "cut-size" is the aerodynamic diameter, in micrometers of a theoretical spherical particle of unit density that has a 50% chance of being captured and is designated “d50.” At normal temperature and pressure, the d50 for a typical "spore trap" commonly used is around 2.3 µm. [14] This means that a mold spore whose diameter is approximately 2.3 µm has only a 50% chance of being captured and retained. The other 50% of those spores pass through the sampler and are not captured. This characteristic is *not* a flaw with the devices – the products, such as the Zefon product, are very well made and appear to

[12] Macher JM, *Data Analysis: Chapter 13 Bioaerosols Assessment and Control* 1st. Ed, 1999

[13] In almost 40 years of reviewing "mold testing" reports, I never encountered a single report, where the testing has been performed correctly, or where the Home Inspector has ever performed a statistical analysis of their data, or where the have established data quality objectives, or where they have actually measured the spore concentrations in the homes they are testing.

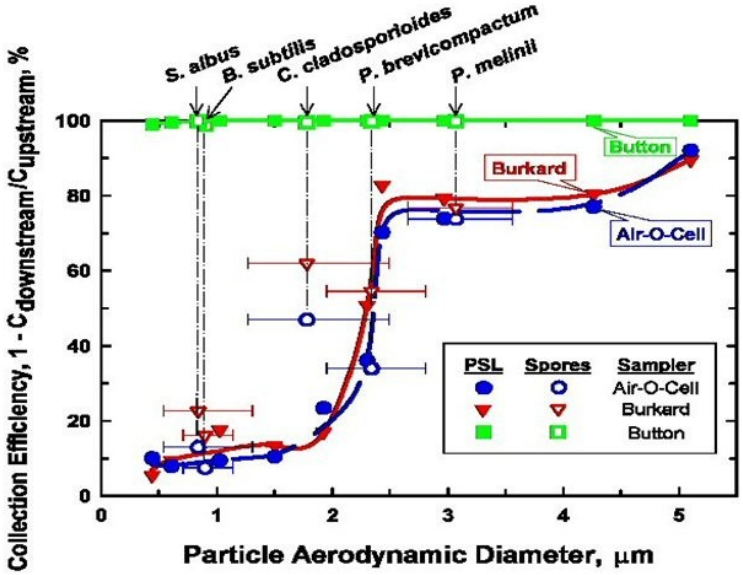
[14] Saulius T, Willeke K, Reponen T, Trunov M, *Particle Cut-Size Evaluation –Final Report* Nov 1998, Internal Report by Zefon International-Analytical Accessories, 2860 23rd Ave, St. Petersburg, FL, 33713

provide high consistency; however, they perform *exactly as advertised*, and it is up to the investigator to understand the limitations of the equipment they are using. One cannot use an X-ray machine to determine the electrical charge on a car battery regardless of how good the X-ray machine is. So it is with spore traps. All equipment must be used within the context of it's inherent limitations.

Importantly, the preponderance of fungal spores that we see in indoor air, belong to genera such as *Cladosporium*, *Penicillium* and the *Aspergilli* and the spore diameters for these genera happens to be exactly within the same range as the cut-size for the samplers. The *Cladosporia* (e.g. *C. cladosporioides*) have a diameter of 1.8 to 2.3 µm (depending on relative humidity[15]), the *Aspergilli* (e.g. *A. versicolor*) 2.4 µm, and members of the *Penicillia* (e.g. *P. brevicompactum*) have a diameter of 2.2 µm.[16]

For some manufacturers, the d50 value is unknown; for example, I have contacted the manufacturer of the "M5" cassette[17] for the capture curve for their product, and they stated they didn't have that information readily available, but they would try to look into it and get back to me. I never heard from them again.

Although some early authors suggested that real collection efficiency curves may be approximated with a sloping straight line (which would aid in increasing the interpretive value of spore trap data), more reliable information indicates the collection efficiency is much more complex (see below).



Capture Characteristics (Saulius)

[15] Reponen T, Willeke K, Ulevicius V, et al, *Effect Of Relative Humidity On The Aerodynamic Diameter And Respiratory Deposition Of Fungal Spores*, Atmospheric Environment Vol. 30, No. 23, pp. 3961-3974, 1996

[16] Reponen, T., Nevalainen, A., Willeke, K., Grinshpun, S. *Biological Particle Sampling* In: Baron, P., Willeke, K. *Aerosol Measurement, Principles, Techniques, and Applications*, 3rd ed. John Wiley and Sons (2001).

[17] The manufacturer was unable to provide very much information about their product. They state that the d50 "*is seen to be about 1 µm*." They were otherwise unsure about the capture characteristics of their product.

Also, as the sampling altitude increases, and/or the sampling temperature increases, the cut-size also increases; as the airflow rate through the sampler increases, the cut-size decreases[18] and even more curious, the actual effective cut-size for the slit impactor can change unpredictably as the mixture of spore sizes changes.[19] Similarly, small variations in the air flow rates of the samplers can result in large shifts in the capture curve.[20] Even this is further complicated by the fact that the spore sizes themselves, while suspended in the air, are dynamic and their size can change as a function of the relative humidity in the air [21]

Therefore, if there is a temperature difference between indoor and outdoor air, or there is a difference between the relative humidity between the indoor air, or there are different genera profiles between indoor air, then even if there were no other problems, the cut-size is different making comparisons unreliable. Again, this become just another link in a very long chain of errors that all add up to invalid numbers.

As if that wasn't bad enough, airborne spores can develop static electrical charges which can be sufficiently problematic to deflect the spores as they pass through the collection device.[22] Believe it or not, even the color of the spores interfere with their collection efficiency, with more opaque spore moving away from light sources and lighter or transparent particles moving towards light sources.[23] None of this is known by Home Inspectors or "certified" mold goobers collecting these samples because they have absolutely no legitimate training, and frankly, they don't care – they get to charge their clients more money for bogus tests and the client only gets misinformation in return for their money. Mold "testing," although mostly useless, is extremely profitable.

To illustrate the practical upshot of the d50 problem, let's use an imaginary scenario. Let's pretend we have a magical laboratory that can actually analyze the samples with perfect

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[18] Saulius T, Willeke K, Reponen T, Trunov M, *Particle Cut-Size Evaluation –Final Report* Nov 1998, Internal Report by Zefon International-Analytical Accessories, 2860 23rd Ave, St. Petersburg, FL, 33713

[19] Cadle RD *The Measurement of Airborne Particles* (1975), (referencing seminal work by Ludwig, FL *Env. Sci. Technology* 2, 1968).

[20] Scott JA, Summerbell RC, Green BJ, *Detection of indoor fungi bioaerosols*, Chapter 13 *Fundamentals of mold growth in indoor environments and strategies for healthy living*, (Olaf C.G. Adan, Robert A. Samson Eds.), DOI 10.3920/978-90-8686-722-6_13, Wageningen Academic Pubs., 2011

[21] Reponen T, Willeke K, Ulevicius V, et al, *Effect Of Relative Humidity On The Aerodynamic Diameter And Respiratory Deposition Of Fungal Spores*, Atmospheric Environment Vol. 30, No. 23, pp. 3961-3974, 1996

[22] Scott JA, Summerbell RC, Green BJ, *Detection of indoor fungi bioaerosols* (p. 359 of Chapter 13 of *Fundamentals of mold growth in indoor environments and strategies for healthy living*, (Adan OCG, Samson RA, Eds.), DOI 10.3920/978-90-8686-722-6_13, Wageningen Academic Publishers 2011)

[23] Cox CS, *Physical Aspects of Bioaerosol Particles*, Chapter 3 of *Bioaerosols Handbook*, Cox CS, Wathes CM, Eds., Lewis Pubs. 1995.

precision and without any errors of any kind.[24] Let's also imagine that we have a perfect slit sampler and perfect mold spores that have no electrical charges and no color difference, etc. Everything is perfect in every way.

Also, imagine that we have an elaborate, highly sophisticated test chamber into which we can perfectly suspend and maintain known concentrations of mold spores. So, we select 12 different molds and we introduce **exactly** 100 monodispersed spores per cubic meter of air into the chamber for each type of mold. In the table below, Column A is the genus of mold, Column B is the spore size, Column C is the collection efficiency based on spore size, Column D is the actual spore concentration, Column E, therefore, is the concentration reported by the laboratory (because those are the spores that were actually trapped and retained by the spore trap). The lab report correctly concludes the sample indicates the air has 540 spores/m3 even though the air actually contains 1,200 spores per cubic meter.

Column A	Column B	Column C	Column D	Column E
Species	Spore Size (µm)	Collection Efficiency	Actual Spore Concentration Spores/m3	Spore Concentration (spores/m3) Reported by Lab
Spore A	1	0.1	100	10
Spore B	30	0.9	100	90
Spore C	1	0.1	100	10
Spore D	2	0.3	100	30
Spore E	1.5	0.2	100	20
Spore F	5	0.7	100	70
Spore G	2	0.3	100	30
Spore H	10	0.7	100	70
Spore I	2.5	0.5	100	50
Spore J	2.5	0.5	100	50
Spore K	15	0.9	100	90
Spore L	1.5	0.2	100	20
Total spore concentrations			1,200	540

So for this simple example, we know the standard air concentration is exactly 1,200 spores per cubic meter of air (because that is what we put in). But the spore trap was never designed to permit the determination of the actual spore concentration. And even with perfect sampling and perfect analysis, the result from the lab is already off by 50%. Therefore, even under impossibly perfect conditions the method used by Home Inspectors cannot meet the ±25% accuracy as specified in the ACGIH reference.

[24] We know, of course, that the precision and accuracy of spore count analysis is extremely poor. See: Robertson LD, et al, *A multi-laboratory comparative study of spore trap analyses* Mycologia, 103(1), 2011, pp. 226–231. DOI: 10.3852/10-017

But it gets worse…

Now let us say, we are going to compare that reported laboratory value with another reported value on the laboratory report from a different test chamber. The second value also had a laboratory report of exactly 540 spores/m3. Well according to Mr. Jones at Scott Home Services, it is perfectly valid to compare two values on a laboratory report to see which one has the most mold. So let's now look at the actual breakdown of the spores in the second chamber…

(Drum roll, please……)

Column A	Column B	Column C	Column D	Column E
Species	Spore Size (µm)	Collection Efficiency	Actual Spore Concentration	Spore Concentration Reported by Lab
Spore A	1	0.1	520	52
Spore B	30	0.9	29	26
Spore C	1	0.1	389	38.9
Spore D	2	0.3	289	86.7
Spore E	1.5	0.2	378	75.6
Spore F	5	0.7	37	25.9
Spore G	2	0.3	198	59.4
Spore H	10	0.7	41	28.7
Spore I	2.5	0.5	48	24
Spore J	2.5	0.5	60	30
Spore K	15	0.9	22	19.8
Spore L	1.5	0.2	365	73
Total spore concentrations			2,376	540

Ooopsies… Although the two laboratory reports were exactly the same, the second chamber has twice as many spores as the first. Now imagine that, the first sample represents the outdoor sample Mr. Jones collected and the second sample represents the interior of the home Mr. Jones is "testing."

Mr. Brett Jones has a problem. He has just reported to his client that their indoor spore concentration was the same as the outdoor spore concentration, when in fact, the indoor spore concentration was twice as high as the outdoor. Like others who are performing such bogus "comparisons," he is entirely unaware of sampling theory, aerobiology and the limitations of both the equipment, protocols, and the analysis techniques and he believes the laboratory reports provide two datum that can be compared together in a meaningful manner. As should be obvious from the above table, it would be exceedingly easy to provide an example where the indoor air has much higher spore concentrations than the outdoor air, but the laboratory reports a much higher concentration in the outdoor air than in the indoor air.

Home Inspectors and "certified" mold goobers who falsely claim they have expertise in mold issues as evidenced by their "samples" and laboratory reports, actually indicate they are completely untrained as evidenced by the same and as evidenced by such practices as "indoor-to-out-door" comparisons.[25]

For those who are claiming such expertise in these matters, but still performing the bogus sampling, we have to conclude they are knowingly defrauding their clients by knowingly providing them with false information.

In my opinion, anyone who is collecting air samples for mold, as is being done by Home Inspectors and "certified" mold goobers must necessarily fall into one of two categories.

1) Either they are entirely ignorant of these issues and completely untrained – in which case they have no business pretending to being competent in the subject matter of indoor molds and they should not be engaging in work in this area and they have no business collecting the samples in the first place.

   OR

2) They understand these problems (as they claim) and they understand their samples are invalid and they are just lying to their customers, and ripping them off by pretending their samples are valid, when they know that is not the truth. That is, they are dishonest crooks defrauding their clients.

Response to Mr. Brett Jones with Scott Home Inspections

In the final section, I will address the comments by Mr. Brett Jones which prompted this discussion.

Mr. Jones

> *"100% wrong 100% of the time" isn't science—it's rhetoric.*

Response

No, Mr. Jones. For the reasons I have stated above (and for the multitude of reasons I have stated elsewhere), the samples you are collecting are 100% incorrect 100% of the time. But because you do not possess the expertise you claim in this field, you don't understand either the math or the methods you are using. Again, all you have to do is present a technical argument to the contrary. You haven't done that and you have not shown us even one of your project reports where you can demonstrate that you are not like the other scammers and you are actually collecting and interpreting data correctly.

[25] Elsewhere, I have discussed the history of the bogus "indoor-to-outdoor" myth.

Mr. Jones

> *Spore trap sampling (like Breeze ST cassettes) absolutely has limitations. No one credible is claiming it captures everything in the air stream. It's an inertial impactor with a known d50, meaning capture efficiency varies by particle size. That's basic aerosol physics, not a secret. But that doesn't make the data "bogus." It makes it context-dependent.*

Response:

But you have been unable to provide any examples of where you have established the context where you have justified your comparisons. You have maintained that such comparisons are *necessarily* valid. In fact, it would appear from your posts that until I raised the issue of the spore trap d50, you had otherwise been completely unaware of the issue. I would be keen to see an example of one of your reports where you have fully explained these issues to your client and placed those data in the context that made the comparison valid.

Mr. Jones

> *The majority of common indoor spores—like Aspergillus / Penicillium and Cladosporium—fall within the effective capture range (~2–10 µm) and are collected reliably enough for comparative analysis.*

Response:

This comment actually contradicts your previous comment since it is a categorical declarative that is not context-dependent. You can't have it both ways.

Mr. Jones

> *These samples are semi-quantitative by design, which is exactly how organizations like AIHA and ACGIH describe them.*

Response:

Again, you reference organizations, but it appears you haven't actually read the referenced document and/or you lack the technical knowledge to understand the science related documents and you are misunderstanding what is being said. According to the AIHA[26]

> *Although results are expressed as spores/m3, spore trap sample results are,* **at best***, semi-quantitative and do not relate to either the area of visible mold damage…*

Therefore, contrary to your false claims, the AIHA doesn't identify the spore traps as semi-quantitative, the AIHA is stating that even at their very best, even when samples have been collected properly and which have been collected according to a pre-prepared sampling plan according to established DQOs, and an identified hypothesis and when the samples are interpreted according to proper statistical analysis – even under all the best of circumstances, the spore traps are **at best** semi-quantitative.

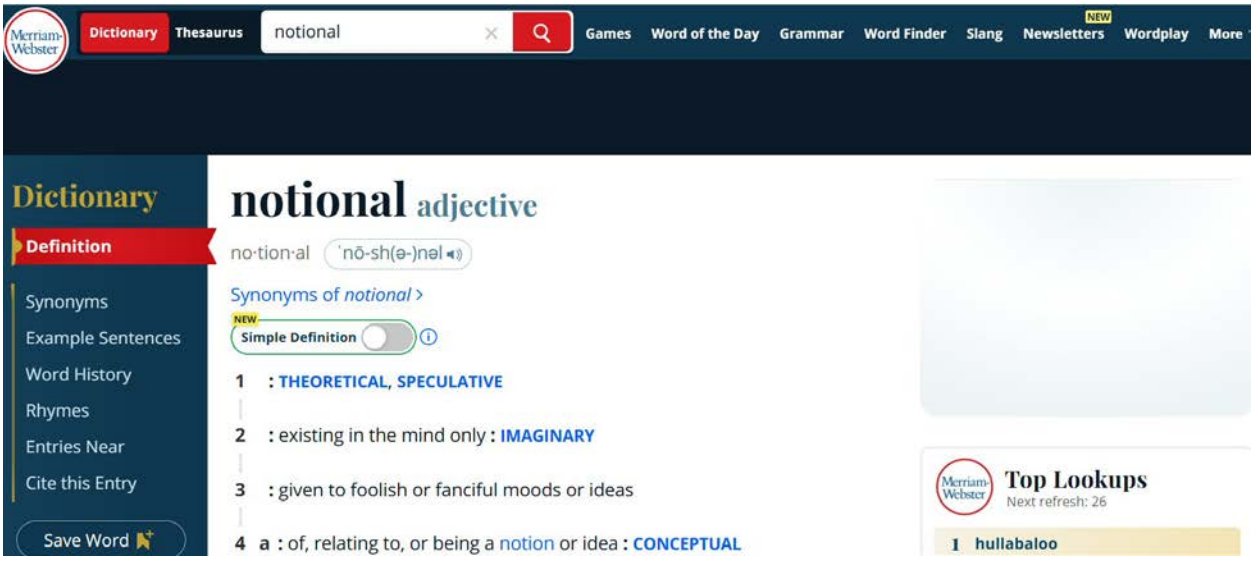
The AIHA is not referring to the kinds of willy-nilly samples you are collecting and the AIHA is certainly not referring to the kind of bogus comparisons you are advocating. How do we know?

[26] FAQs About Spore Trap Air Sampling for Mold for Direct Microscopical Examination, October 23, American Industrial Hygiene association, 2025

Because through the AIHA literature the AIHA discusses such matters and also because in the very same document as above, the AIHA states:

> *For both spore trap samples and culture-based analysis, concentrations thus obtained are **notional at best**.*

What does the word "notional" mean? Is "notional" a synonym for "semi-quantitative"? Let's look at the common, ordinary meaning of the word as expressed by the widely accepted Merriam-Webster dictionary:



This is explicitly spelled out in the same AIHA document:

> *The variability resulting from these, and other, environmental conditions only add to the variabilities associated with the sampling and analytical methodology, as well as spatial and temporal variabilities, and must be considered when evaluating and interpreting any air sample results. The greater the variability of the environmental conditions, the more difficult it becomes to evaluate and interpret the results.*[27]

Again, the AIHA:[28]

> *All accredited laboratories are required to maintain the laboratory's coefficient of variation (a measure of t his variability) for the method. This coefficient of variation **must** be considered when interpreting sampling and analytical data. For example, the higher the coefficient, the greater the variability in the data and the greater the need for caution in interpreting and using that data.*

[27] FAQs About Spore Trap Air Sampling for Mold for Direct Microscopical Examination, October 23, American Industrial Hygiene association, 2025

[28] FAQs About Spore Trap Air Sampling for Mold for Direct Microscopical Examination, October 23, American Industrial Hygiene association, 2025

Mr. Jones

The industry standard use is comparison (indoor vs. outdoor, room-to-room, pre/post remediation)—not absolute exposure or health-risk determination.

Response:

Here, again, we need to understand that words have meanings. So "industry standard" begs the question: Which *industry* and what *standard*?

The "industry" in question is the fear-based, anti-science, dishonest and unethical mold-testing industry. The "standard" in question, doesn't exist. Rather, it would be more accurate to state "A common practice in the charlatan mold-testing industry is to pretend to compare indoor spore concentrations to outdoor spore concentrations." This boils down to an *argumentum ad populum* fallacy: "Well, everyone else in the (mold scam) industry is doing it, so it must be correct."

Mr. Jones:

You're also conflating two different arguments:
"Air sampling has limitations and must be used appropriately." → True
"All air sampling is invalid and junk science." → Not true

Response:

I have never said "All air sampling is invalid and junk science." That is something that you have simply invented and falsely attributed to me. We perform air sampling all the time (we almost never perform air sampling for molds, because it is virtually never needed, and it is so expensive to do correctly, virtually no one is willing to pay for it).

But what IS true and what I HAVE said is "All mold air sampling as commonly performed (and certainly always by Home Inspectors and "certified mold goobers) is 100% wrong 100% of the time." That is an objective fact, and you have been challenged to prove me wrong. You haven't been able to do that, so far, all you have done is tell me that you don't like what I have said. You haven't offered even the slightest technical argument to support your position.

Mr. Jones

Even the guidance you cited (AIHA, EPA, CDC) doesn't say sampling is invalid—it says:
Don't rely on it in isolation
Use it to answer a specific question
Pair it with inspection and building science

Response:

False. I have quoted over and over and over again statements from these (and other) organizations that clearly and explicitly condemn the sampling practices as currently used by Home Inspectors and "certified" mold goobers.

You have never read those documents by those organizations, because if you did, you would actually understand what those organizations are really saying. To be sure, you will be incapable of finding any language in any of the above organizations that affirms your practice of collecting one (or two or three) indoor samples and willy-nilly pretending to compare that with an outdoor sample.

Mr. Jones:

That's exactly how many of us use it in the field.

Response:

False. In my experience there is not a single Home Inspector in the country that is doing it that way. To the extent that you clearly lack any legitimate expertise in this field, and you refuse to show us your work, it's reasonable to conclude that you have never done it that way. Again, I repeat my challenge. Show us all here a *bona fide* report of yours where you have developed a sampling plan, based on an established hypothesis, according to clearly delineated data quality objectives, and then interpreted those data within the context of that plan. Answer: You can't, because you have never done so. Furthermore, in my almost 40 years of reviewing hundreds of "mold reports" by scam mold inspectors from across the country I have never ONCE, seen a single example where a "mold inspector" has ever performed valid sampling or sampling interpretation.

Mr. Jones

And on the legal side—Daubert doesn't exclude imperfect science. It excludes unreliable methodology and misapplication. Spore trap sampling, when used within its known limitations and properly interpreted, has been admitted plenty of times.

Response:

Correct – but you won't be able to cite a single case where this has occurred. Furthermore, you cannot find a single one of your projects or a single project by one of your colleagues where such sampling was conducted "*within its known limitations and properly interpreted* ." Indeed, based on your comments, you would not be capable to even identify the difference between bogus testing and sampling "*used within its known limitations and properly interpreted* ."

Mr. Jones

Overstating what the data means is a problem. Using it as one piece of a larger assessment is not.

Bottom line: Spore traps don't capture everything—but they capture enough of the right particles to be useful when used correctly. Calling that "100% wrong" ignores how the method is actually designed and used in practice.

Response:

Again the operative phrase is "when used correctly." But you would be incapable of finding a single one of your projects or a single project by one of your colleagues where such sampling was conducted "correctly." Indeed, in the overwhelming, vast, majority of projects (in my experience, 100% without a single exception), the consultant does what you advocate – collecting samples and interpreting data that is 100% invalid 100% of the time.

I hope this helps.