Technical Review
of

Health Effects Associated with Indoor Marijuana Grow Operations

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EXECUTIVE SUMMARY

On September 13, 2012 the Division of Environmental and Occupational Health Sciences, National Jewish Health (NJH) located in Denver, Colorado, announced the release of an unpublished report prepared by staff members of National Jewish Health. The report is titled "*Health Effects Associated with Indoor Marijuana Grow Operations*."

The report was supported by Grant No. 2010-DJ-BX-0316 awarded by the Bureau of Justice Assistance. According to a press release,[1] the report was "designed to provide advice about precautions and protective equipment law enforcement agents should wear when investigating indoor marijuana grow operations."

The report concluded that hazardous levels of molds were found at indoor marijuana grow operations and that these levels presented a significant hazard to first responders responding to these grow operations.

According to the press release:

> Police and other first responders may be exposed during busts of illegal marijuana-growing operations to dangerous levels of mold that could lead to potentially deadly respiratory diseases, researchers said Monday.

The report recommended various forms of personal protection equipment to control the reported hazards.

Within hours following the release of the report, undue alarm spread through the law enforcement community; first responders across the country and as far away as England were contacting the offices of this reviewer (Connell) for information regarding the reported hazards.

FACTs has reviewed the report issued by National Jewish Health (NJH) and upon reviewing the report, we have concluded the following:

- The conclusions by the authors are not supported by their data.
- The authors used improper mathematical manipulations in the presentation of their data.
- The authors failed to employ scientifically valid sampling protocols in their assessments of indoor molds.
- The authors employed toxicological precepts that are untested and unscientific.
- The concentrations of the molds reported in the marijuana grows were not valid.
- The concentrations of the molds reported in the marijuana grows were not particularly elevated.

[1] Jason Pohl The Denver Post, September 11, 2012

- The concentrations of the molds reported in the marijuana grows were significantly lower than mold concentrations reported from other agricultural operations, and which are generally regarded as safe.
- The report contained many technical errors and false assumptions that are not supported by accepted science.
- The report does not contain any information, or sampling data, within any known confidence that indicates molds present an otherwise unrecognized health hazard to first responders.

General Comments

This is a technical review of the unpublished work released by NJH. An exhaustive critical review of the report would be difficult due to the foundational errors contained therein. Therefore, no attempt has been made to exhaustively review the NJH report. Rather, the objective of this discussion is to provide sufficient information to demonstrate that the report lacks credibility, and failed to demonstrate an hazard to first responders.

In general, the document is poorly written from a style and grammatical perspective and is fraught with misspelled words, poor grammar, unsupported propositions, and convoluted statements such as the following:

> In addition, we expect the species inside the house to be similar in abundance and species to the species and abundance outside.

It would appear that the document was prepared without the benefit of any kind of internal review, peer review, proofreading, editing or consideration to fact-checking or technical vetting for scientific validity.

Throughout the document, the author(s) make many unsupported statements without any references or citations. For example:

> Emergency personnel and law enforcement officers entering these facilities on a regular basis have reported upper respiratory irritation, skin rashes, and other symptoms associated with these exposures.

Many of the references are presumably not cited since there is no actual reference, and the statement is in fact contrary to published data. For example, the following unsupported quote appears in the NJH report wherein the authors have not provided any references:

> A number of reports have suggested that the principal concern in indoor marijuana grow operations is the presence of excessive mold spore levels due to the elevated temperatures, humidity, and organic material in these operations.

In fact, there are no valid studies, to the knowledge of this reviewer that have suggested this conclusion. Large portions of the NJH report appear to be the same language as that

which appeared in another document[2] co-authored by one of the NJH report authors[3] wherein similar unfounded statements appear; for example in the following quote:

> The presence of fungal growth in IMGOs has resulted in fungal contamination in many marijuana samples. McLaren et al. found that 13/14 marijuana samples were contaminated with excess amounts of Aspergillus.(12)

The cited reference (given as footnote 12) is for "McLaren, J., W. Swift, P. Dillon, and S. Allsop: *Cannabis Potency and Contamination: A Review of the Literature*. Addiction 103(7):1100–09 (2008)." However, if one goes to the McLaren citation, one finds that nowhere within the cited literature does the referenced statement of finding occur. That is, fact-checking reveals that McLaren *et al* did not report finding that 13/14 marijuana samples were contaminated with excess amounts of *Aspergillus*.

Throughout the present NJH document, dozens of such assertions are claimed to be shared by other authors, other studies and other reports – but nowhere in the NJH document have the authors identified those authors, or provided standard citations of any of the literature, authors, reports or studies to which they allude.

Throughout the document we also find conclusions and observations that are not supported by the NJH data; and in fact, in many cases, the NJH conclusions are actually contradicted by their own data. For example, the authors conclude:

> These data indicate that the number of MGO's with elevated spore levels appear greatest when the number of plants exceeds 50.

The actual data presented by the authors in the NJH document, demonstrates the opposite, and as the number of plants increased in the marijuana grows studied, the average spore concentrations are lower, not higher on a per plant basis. (See Figure 1, below).

[2] Clandestine Indoor Marijuana Grow Operations – Recognition, Assessment and Remediation Guidance American Industrial Hygiene Association Stock Number: EMRG10-764 ISBN: 978-1-935082-17-0

[3] John Martyny

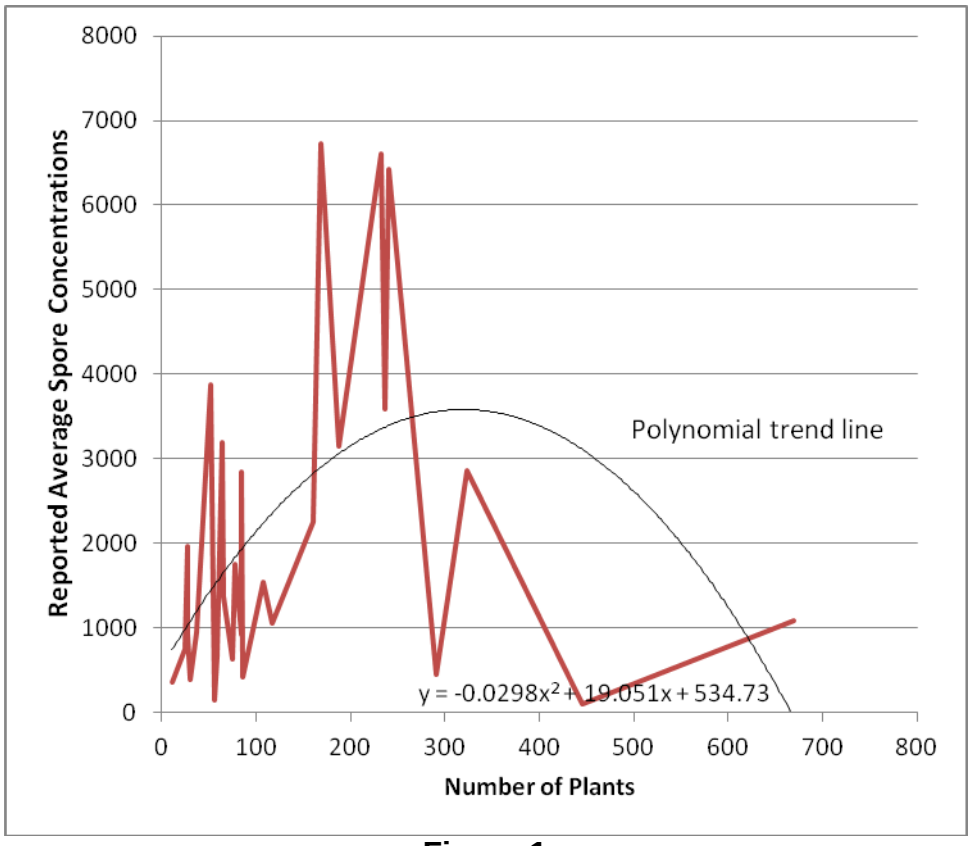

Figure 1
Spore Concentrations as a Function of Plant Number

In other places, the NJH statements are in stark contradiction to themselves and to published literature and accepted facts. For example, on Page 7 of the NJH report, the following statement is made:

> Since not all mold spores that are captured using the Anderson *(sic)* Cascade Impactor are able to grow due to viability issues, the non-viable spore levels are usually higher than the viable mold levels.

(Throughout the NJH report, the Andersen sampler is incorrectly spelled "Anderson"). In fact, the statement is simply not true and it has long been known that the sampling protocol used by the NJH authors is not capable of the representative enumeration of airborne spores, and when sufficient numbers of samples are collected in a valid manner, we see a complex relationship between "total" spore traps and the Andersen N6 samplers used by NJH. At the altitude of the NJH studies, low spore counts are biased high with the Andersen N6 sampler (vis-à-vis total spore traps) and at higher spore concentrations, the "total" spore traps are favored; parity occurring at approximately 200 spores-CFUs per cubic meter of air. The graphic below depicts the results of a study of simultaneously collocated slit impactor samples compared with Andersen N6 samplers. [4]

[4] Connell CP, *Sampling Strategies and Data Interpretation*, Presented in Huntingdon, England (Nov. 2011)

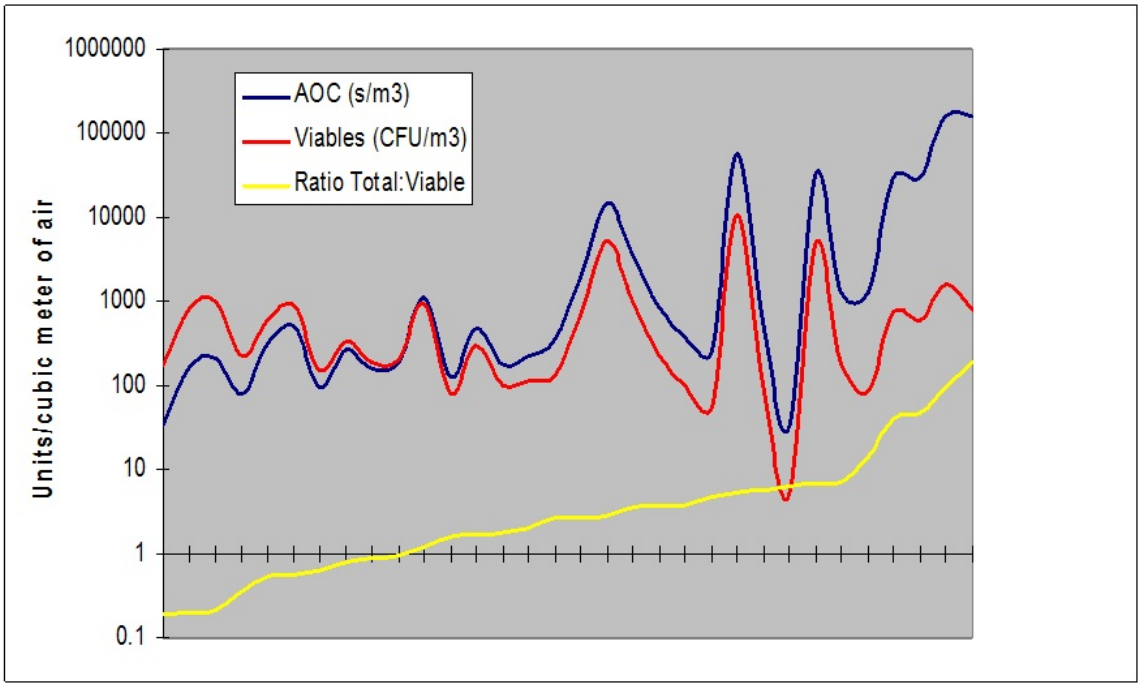

Figure 2
Comparison of Spore-traps and Andersen Samplers

The physics behind this phenomenon have been well understood for decades. However, when the NJH author(s) encountered this phenomenon it was contrary to their expectations and the author(s) concluded:

> The biggest difference between the two tables are the results for MGO#14 where the viable levels of spores were much higher than the number of counted spores. The reason for this discrepancy is unknown at this time.

The reasons for the observed phenomenon are very well known to established science and several of the issues were in fact described by Andersen in 1958.[5] The statements in the NJH report exhibit a fundamental lack of understanding of the sampling equipment used in the study. Throughout their report, the NJH authors refer to the erroneous notion that "total" spore counts were enumerated or "total viable counts" when in fact, the sampling equipment used by NJH was entirely incapable of such "total" enumerations. The Andersen sampler employed and the slit impactor employed by the authors were never designed to be total spore traps, and neither are capable of representing total spores (or even total "viable" as erroneously stated by the authors). The physics upon which the two samplers work are so completely different that it is impossible to compare a slit impaction "spore trap" result to the Andersen N6 sampler without very complex mathematical standardizations – none of those were employed, and the NJH authors merely compared raw values between the samplers.

[5] Andersen, A. A. 1958. *New sampler for the collection, sizing, and enumeration of viable airborne particles*. J. Bacteriol. 76:471- 484

Contrary to that presented by NJH, each sampling method has only a limited inherent ability to enumerate specific types of spores. NJH erroneously refers to "total spore counts" in their report; however, the sample devices (the spore trap and the Andersen samples) each have complex collection efficiencies that are very well established.[6]

Unfortunately, the authors never identified the actual type of slit spore trap they employed. Nevertheless, all such impaction spore traps (as exemplified by the Andersen cascade impactor and Air-O-Cell™ sampler and others) 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 the "total spore trap" used by NJH (if it was one of the common commercially available slit-impactor spore traps) is reported as around 2.3 µm. [7] This means that a mold spore whose diameter is approximately 2.3 µm has only a 50% chance of being captured. Now, by comparison, the Andersen sampler used by NJH has a d50 of only 0.65 µm[8] which means that even on the face, it is impossible to compare Andersen samplers with the impaction spore traps since both devices have completely different capture characteristics and even under identical atmospheric conditions produce completely different results.

Importantly, the preponderance of organisms that we see in indoor air, as discussed by the NJH authors, belong to genera such as *Cladosporium*, *Penicillium* and the *Aspergilli*. The spore diameters for these organisms happens to be exactly within the same range as the cut-size for the devices NJH called "total" samplers. The *Cladosporia* (e.g. *C. cladosporioides*) have a diameter of 2.1 µm, 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.[9] We will return to this problem later in the discussion.

Similarly, in other places, the conclusions of the author(s) are not supported by their own data. For example the report states (on page 10):

> There is strong agreement between both the viable and non-viable samples.

In fact, the data present in the report indicates there is virtually no agreement between the two data sets presented in the NJH report. When we match up pairs for the data sets for each grow operation for which the author(s) had slit impactors (erroneously referred to in the document as "non-viables") and Andersen samples (erroneously referred to by the

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[6] Macher J. Burge HA, *Sampling Biological Aerosols* Chp. 22 in *Air Sampling Instruments for Evaluation of Atmospheric Contaminants (ACGIH, 2001)*

[7] 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

[8] Lee KS, Black W, Brauer M, et al *A Field Comparison Of Methods For Enumerating Airborne Fungal Bioaerosols*, Presented at the Proceedings: Indoor Air 2002, Anaheim, California.

[9] 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).

authors as "viable"), we see there is virtually no agreement between the two data sets. In the graphic below, we have plotted the NJH Andersen samples against the NJH slit impactor samples. Graphically "good agreement" would have been represented by a straight sloping line and a linear regression of better than 0.9 (unitless). By applying a standard linear regression, we have compared the two data sets; one as a function of the other (see below).

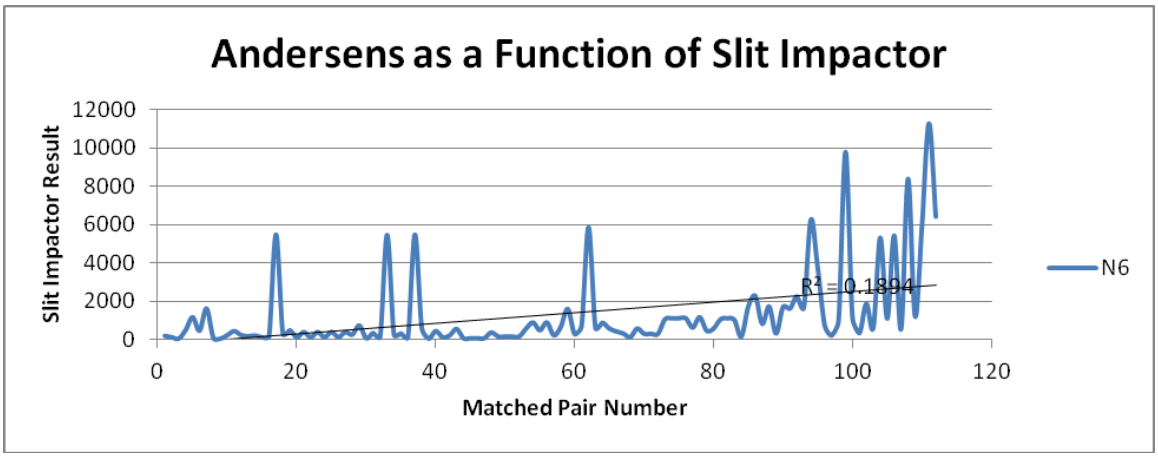

Figure 3
Correlation of NJH Andersen Results with Slit Impaction Results

We see that the correlation is extremely weak (0.1894); when we reversed the variables the correlation was no better (0.0884). Therefore, there is nothing in the data to support the claim "There is strong agreement between both the viable and non-viable samples."

During the press release the authors claimed:

Study finds perilous mold in Colorado pot-growing operations[10]

When one reads the above referenced media account, one finds the statement:

> A team working with National Jewish Health researcher Dr. John Martyny reviewed conditions in 30 marijuana- growing operations in Denver, Littleton and Larimer County and found mold levels at times 100 times higher than considered safe and in a few cases so high that their instruments could not read the levels.

There is no level of mold spores above which the exposure is considered unsafe. Therefore, at no time could NJH have "found mold levels at times 100 times higher than considered safe."

[10] Jason Pohl The Denver Post, September 11, 2012

In fact, nowhere in the NJH document have the author(s) documented, supported, or substantiated any such finding.

A false alarm has been raised to which first responders are reacting. There is a pressing need to ensure that financial resources and anxieties are reserved to actual hazards present in marijuana grow operations.

Further, the statement "…in a few cases so high that their instruments could not read the levels." is actually a statement concerning the poor sampling techniques used in the NJH investigation. In the ambient counts for the grow rooms, fully one out every five samples (22%) was censored due to a field error of oversampling. The "maximum" spore concentrations above the readable limit in most cases were below normal outdoor spore concentrations. For example, one of the readings that was identified as "so high that their instruments could not read the levels" was only 5,436 spores per cubic meter of air (spores/m3). On the day this technical review was initiated (September 17, 2012), the primary reviewer (Connell) documented the outdoor spore counts around the country and found the following:

Location and Reference	Reported	Outdoor Spore Count (9/17/12)
New Castle, Delaware[11]	4,972	spores/m3
Springfield, Missouri[12]	16,587	spores/m3
Houston, Texas[13]	9,579	spores/m3
Milwaukee, Wisconsin[14]	9,350	spores/m3
Rochester and Olmsted County, Minnesota [15]	5,449	spores/m3
Chattanooga, Tennessee[16]	1,153	spores/m3
Anchorage Alaska[17]	6,363	spores/m3
Kansas City, Missouri[18]	3,236	spores/m3
Plano Texas[19]	9,767	spores/m3

Table 1
Reported Outdoor Spore Counts

[11] Delaware Department of Natural Resources and Environmental Control http://apps.dnrec.state.de.us/Pollencount/PollenCount.aspx

[12] Springfield County Health Department Springfield, http://health.springfieldmo.gov/index.aspx?NID=145

[13] City of Houston, Health and Human Services http://www.houstontx.gov/health/Pollen-Mold/index.html

[14] Dr. Gary C. Steven, M.D., Ph.D Milwaukee County Pollen and Mold Counts http://www.milwaukeepollen.com/

[15] Rochester and Olmsted County Minnesota http://www.mayoclinic.org/allergy-rst/pollencount.html

[16] Chattanooga Air Pollution Control Bureau, http://www.pollutionsolution.org/air_monitoring/daily.aspx

[17] Anchorage Air Quality Program Department of Health and Human Services, http://www.muni.org/Departments/health/environment/AirQ/Pages/AirQualityPollen.aspx

[18] The Children's Mercy Hospital, http://www.childrensmercy.org/Pollen/Count/count.asp?city=1&page=

[19] Dr. Jeffrey Adelglass, M.D., F.A.C.S., http://www.entdocs.com/thismonthspollen.htm

Therefore, just on a cursory review, fully 67% of normal outdoor spore counts from around the country would have been considered "…so high that their instruments could not read the levels." And yet finding these levels of spores is not alarming, it is quite normal, and there is no evidence that these kinds of spore counts increase the risk of injury or adverse health effect to anyone, including the most sensitized persons who suffer from hay-fever.

As will be described later in this discussion, although the sampling *equipment* used in the NJH study is legitimate, the sampling and "testing" *protocols* employing that equipment were not valid, and are not accepted by the scientific community.

Overall, this NJH document is not supported by good science. The work does not rise to the level of legitimate science or good technical reporting, and is not credible.

General Statement on Authority

Most first responders with whom the primary reviewer[20] has spoken, presume the NJH report is a scientific finding, and that the opinions therein are official positions. However, the report does not contain the endorsement of <u>any</u> independent reviewers, agency, organization, or any other entity. There is no information in the document to indicate that it was submitted for any kind of external peer review process or that it was otherwise vetted by any known authoritative organizations. The conclusions have not been otherwise accepted by any known scientific body, regulatory agency or other recognized body. The report was exclusively an internal work containing conclusions based entirely on personal opinions not supported by objective facts.

The disclaimer on the cover page of the report explicitly states that the findings in the document are personal opinions of the author(s), and do <u>not</u> represent the official position or policies of the United States Department of Justice.

> This project was supported by Grant No. 2010-DJ-BX-0316 awarded by the Bureau of Justice Assistance. The Bureau of Justice Assistance is a component of the Office of Juvenile Justice and Delinquency Prevention, and the Office for Victims of Crime. <u>Points of view or opinions in the document are those of the author and do not represent the official position or policies of the United States department of Justice.</u>

ASSESSMENT OF RISK

The assessment of hazard and risk, and the subsequent selection of personal protection equipment to mitigate unnecessary risk is at the heart and soul of the practice of Industrial Hygiene.[21]

[20] Caoimhín P. Connell

[21] Jaylock MA, Lynch JR, Nelson DI *Risk Assessment Principles for the Industrial Hygienist* American Industrial Hygiene Press 2000

When selecting appropriate respiratory protection against virtually any insult, (chemical, biological, radiological, etc), one must have an idea of hazard posed by the material. Thus, it would be inappropriate to select a respirator identified as "dusts, fumes and mists respirator" and expect that respirator to be effective against carbon monoxide fumes." Since there is no such thing as "carbon monoxide fumes" (carbon monoxide is a gas, not a fume), a "dust, fume and mist" respirator will be completely ineffective.

Similarly, if a responder is faced with a known toxic material, say toluene, present in an area with a time-weighted average concentration of 1,000 parts per billion (1,000 ppb), and wants to know what kind of respirator is needed, they would discover that no respirator is needed since an exposure to 1,000 ppb of toluene does not have any known health effects and does not pose any known risk.

Therefore, before selecting a personal protection equipment (PPE) ensemble, one typically begins with determining *if* there is a toxic material present and *if* the anticipated or known levels constitute an health hazard. One then identifies the control level to which one is going to control those exposures – that decision making process is globally accepted Industrial Hygiene science.

As an example, let's look at a known chemical hazard; an industrial solvent known as dihydrogen monoxide (DHMO).

- DHMO is a constituent of many known toxic substances.
- DHMO environments have been conclusively demonstrated as being lethal to humans
- Quantities of DHMO as small as a thimbleful have resulted in human fatalities
- Each year DHMO is responsible for thousands of deaths in North America
- Prolonged exposure to solid DHMO causes severe human tissue damage
- Exposure to pure DHMO can causes severe eye irritation
- DHMO is the major component found in acid rain
- DHMO is so strong, it can degrade solid steel
- DHMO is found in virtually every biopsy of pre-cancerous and cancerous tumors

And yet, if this chemical is present in the responder's atmosphere, a responsible health and safety professional would not recommend any PPE for the protection against the hazards of DHMO; in spite of the fact the hazards identified above are absolutely correct. This hazardous substance (more commonly known as "water") is everywhere, and its mere presence or the ability to make it sound exotic does not constitute an hazard to Responder/Receivers even though each of the above hazard statements are correct.

Similarly, undue fear can be generated with mold spores, since molds are exotic, and the recipient of the information encounters strange units of measurement, and otherwise exotic sounding names like "*Stachybotrys atra*" and "*Memnoniella*" and other strange sounding terms. When in fact, every minute of every day every human on the Planet Earth inhales thousands of mold spores without any known adverse health effect.

In their report, the NJH author(s) make the tacit statement that on a particle-to-particle basis, mold spores are more dangerous than asbestos. The US Department of Labor Permissible Exposure Limit for asbestos is 100,000 fibers per cubic meter of air.[22] The NJH author(s), in their report, attempt to argue that exposures to 5,144 mold spore/m3 of air are hazardous and require respiratory protection. This would mean that it is the position of the NJH that mold spores are 20 times more hazardous than asbestos; a position that cannot be supported with accepted toxicological and epidemiological science.

Therefore, before claiming that something presents an health hazard, there must be some objective basis for the claim. Many organizations establish decision thresholds for human exposures to a variety of insults. Hundreds of compounds have regulatory exposure limits, recommend exposure limits, Ceiling Limits, permissible exposure limits and Threshold Limit Values.® These exposure limits are established by the US Department of Labor (OSHA), the American Conference of Governmental Industrial Hygienists, US National Institute of Occupational Safety and Health, and a multitude of other agencies and organizations.

The foundation upon which these levels are based are objective epidemiological and toxicological assessments, risk-benefit equations, and toxicological modeling. "Safe" levels, to which a human may be exposed for a given material, is thus established.

Toxicologically "safe" levels of insults do not change with the weather, or other unpredictable conditions. For example, 1,500 ppm of carbon monoxide is dangerous. If that exposure occurs inside a house, outside a house, in a car, or a factory, or anywhere else - it is still dangerous. If the level of carbon monoxide inside a house is only 2 ppm, that exposure is not dangerous. If 2 ppm carbon monoxide inside the house happens to be ten times higher than the level of carbon monoxide outside the house, but it is still just 2 ppm, then it is still not dangerous; the outdoor concentrations notwithstanding. The level of carbon monoxide outside the house is entirely unimportant – only the human exposure is important.

In the NJH report, no such science was involved in establishing levels referred to as "safe" or "hazardous." Rather, the author(s) of the NJH report invented a new method of assessing risk. In their new method, NJH defines an "unsafe" level (or elevated level) of mold not by the actual human exposure, but rather by the spore concentration <u>outside</u> the building to which the human is <u>NOT</u> being exposed. This is a concept that is entirely unknown to, and therefore unaccepted by, science.

NJH defines hazardous levels of mold as being five times more inside an house than outside the house. According to the NJH report, if a human is exposed to 750 spores/m3, that is "hazardous" if the outdoor spore concentration is only 72 spores/m3; but the same 750 spores/m3 is not "hazardous" if the outdoor spore concentration is say, 1,000 spores/m3. Similarly, 750 spores/m3 is hazardous if the outdoor spore concentration is only 72 spores/m3, but an indoor spore concentration of, say, 4,000 spores/m3 inside is

[22] Title 29, Code of Federal Regulations, Part 1910 (1910.1001(c)(1))

"safe" if the outside concentration is 15,000 spores/m3. There is no objective evidence to support the new NJH argument that exposures to which a person is NOT exposed are more important than the exposures to which a person IS exposed; globally, as presented in this review, there is overwhelming literature to demonstrate the NJH argument is without credibility.

To add to the problem, as described later, the outdoor spore concentrations wildly fluctuate minute by minute and day to day to day and from location to location. So what may be a "safe" level inside a house at noon, may be unsafe one hour later even though the exposure is exactly the same, only the outdoor spore concentration to which one is comparing it went down.

We have already seen in Table 1 above, the normal outdoor spore concentrations vary enormously. Therefore, if someone on September 17, 2012 in Chattanooga, Tennessee, was exposed to 7,000 spores /m3 that would be dangerous, but if the same person was exposed to the same 7,000 spores/m3 air in Springfield, Missouri, that would be OK (in fact that would be a low spore count compared to the outside.)

The concept employed by the NJH author(s) in their study to define an hazard or elevated spore count, or "safe" levels, is not supported by science.

In the graphic below, are actual outdoor spore concentrations for the Denver (Colorado) Metro area (the same area studied by the NJH). The graphic depicts the fluctuations over the course of twelve months. Therefore, if the "safe" level of a mold spore concentration is incumbent on the outdoor levels, the "safe" level will similarly wildly fluctuate, and it will be impossible to set a control level the selected PPE is supposed to provide. The fluctuations depicted in the figure below are similar to the counts reported by other researchers.[23,24]

[23] Corden JM, Millington WM, Didymella *ascospores in Derby*, Grana, 33:2, 104-107 (1994)

[24] Millington W, Corden J *Long term trends in outdoor Aspergillus/Penicillium spore concentrations in Derby, UK from 1970 to 2003 and a comparative study in 1994 and 1996 with the indoor air of two local houses*, Aerobiologia 21:105–113 (2005)

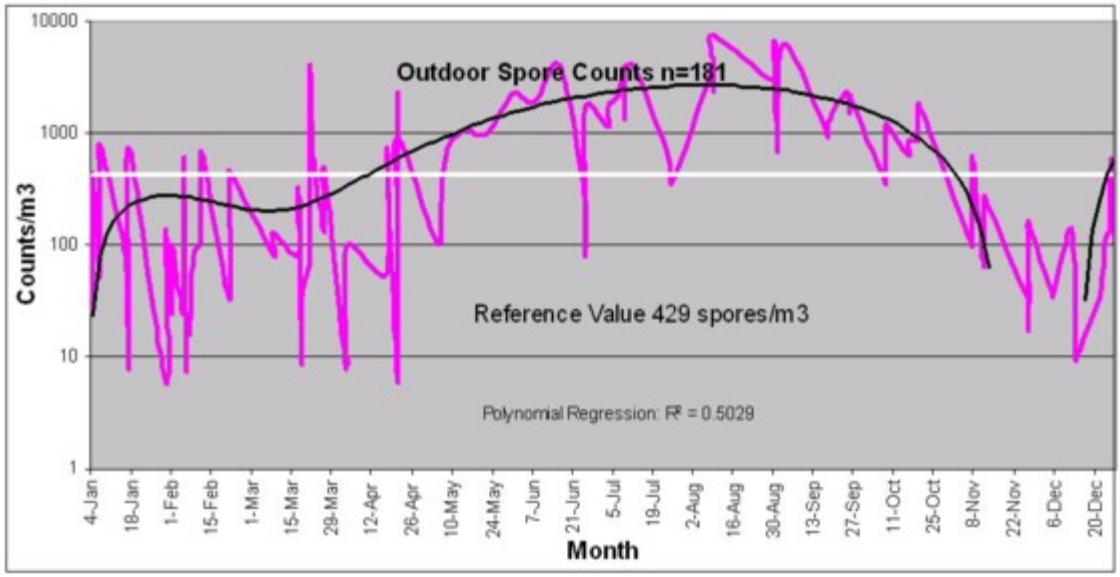

Figure 4
Outdoor Fluctuations in Denver Metro Air[25]

The author(s) of the NJH report cannot scientifically support their claim that mold spores create a risk if the exposure is five (or ten or a hundred) times greater than outdoors, but no risk if the outdoor exposures are the same or higher.

MOLD EXPOSURES in the HUMAN ENVIRONMENT

Mold spores are ubiquitous in the human environment.[26,27] There is virtually no place that one can go and not be exposed to molds and mold spores.[28]

Scientific literature contains hundreds of references regarding mold spores in the normal healthy human environment associated with normal, everyday, ordinary (safe) human exposures.

The sampling protocols used by the NJH team were not scientifically valid (see discussion in the "Sampling" section below), and the sampling protocols were not capable of identifying actual spore counts within any known level of confidence. Having said that, the concentrations of spores reported by the NJH author(s) were simply not remarkable and were not particularly elevated even if the results were valid.

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[25] Connell CP, *Sampling Strategies and Data Interpretation*, (Presented at the University of Vermont, July 2009, ASTM International Johnson Conference: Standardization of Mold Response Procedures)

[26] United States Environmental Protection Agency "Mold Remediation in Schools and Commercial Buildings" EPA 402-K-01-001 March 2001 (updated 6/25/01)

[27] Recognition, Evaluation and Control of Indoor Mold (Prezant B, Weekes DM, Miller JD – Editors), American Industrial Hygiene Association, August 2008)

[28] Burge HA *Bioaerosols*, p.114, 1995, Lewis Publishers

Ambient Spore Concentrations

Arithmetic Mean

Before looking at the NJH data, it is important to look at the manner in which the NJH author(s) have presented their data. NJH has reported "average" spore concentrations. In fact, they presented arithmetic means of two data points; which is a valid mathematical manipulation provided the data set exhibits a Gaussian distribution.

It is an established and scientific fact that particle migration is mainly influenced by particle properties, ventilation conditions and airflow patterns.[29] Airborne particles, (such as spores) in general,[30] and spore concentrations, in particular,[31] within a structure exhibit extremely large spatial variations[32] which tend to be compartmentalized within a given space. It is a well established fact that spore counts of airborne fungal entities exhibit a lognormal distribution throughout the day.[33] This means that the variation between two, three or four samples can be ***huge*** and skewed in one direction (as seen in the above example).

Generally, the geometric standard deviation (GSD) of interday and intraday airborne spore concentrations lies between 1.2 and 2.5 geometric standard deviations.[34] These large variations have been known to legitimate Industrial Hygienists for decades,[35,36,37,38,39] and are similar to those seen by other authors, specific to airborne

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[29] Li Y; Heng J; and Chen Z Study Of Particle Movement In Ventilation System Proceedings: Indoor Air 2002 Anaheim California, 2002

[30] Keady PB; Mainquist L; *Tracking IAQ Problems to Their Source*, Occupational Health & Safety, September 2000

[31] Connell CP, *Field Measurements for Moulds: Spatial and Temporal Variations*, Presented at the ASTM International Conference: Bringing Science to Bear on Moisture and Mold in the Built Environment, Colorado University, Boulder 2006

[32] Macher JM, Chatigny MA, Burge HA *Sampling airborne microorganisms and aeroallergens* In: Cohen BS, Hering SV, eds. Air sampling instruments for evaluation of atmospheric contaminants, 8th ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 589-617.

[33] Macher JM, Chatigny MA, Burge HA *Sampling airborne microorganisms and aeroallergens.* In: Cohen BS, Hering SV, eds. Air sampling instruments for evaluation of atmospheric contaminants, 8th ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 589-617.

[34] NIOSH Occupational Exposure Sampling Strategy Manual, HEW Publication Number 77-173 (1977)

[35] Larsen R.I, A *Method for Determining Source Reduction Required to Meet Quality Standards* JAPCA, 11, 71, 1961

[36] Larsen R.I, A New *Mathematical Model of Air Pollutant Concentration Averaging Time and Frequency*, JAPCA, 19, 24 (1969)

[37] Breslin AJ, Ong, Glauberman H, et al, The *Accuracy of Dust Exposure Estimates Obtained from Conventional Air Sampling* J AIHA, Vol. 8, pp 56-61, (1967)

mold concentrations[40,41,42] some of whom have reported even higher fungal variations in indoor air.[43]

Thus for example, where we see that the NJH team collected two slit impactor samples from Grow Number 19; we see that one sample for the area was 245 spores/m3, and that another sample from the exact same room was 134,000 spores/m3. So which is correct? Which value represents the exposure? In their report, the NJH author(s) merely averaged the two values.

Imagine a pollster goes into the population of an extremely poor community to determine the financial standing of that community. The pollster randomly interviews two people that he encounters. The first person is an individual begging on the side of the street, in his begging bowl is 2.45 rupees. The second person he encounters at the exact same location is a man who steps out of a Rolls Royce Silver Ghost, and informs the pollster that he has 1,340.00 US$ in his pocket. The pollster takes the two data points (even though they don't even represent equal entities), averages them and announces that the "average" occupants in that area walks around with 671.00 US$ in their pocket, and therefore, the area is not poverty stricken, but is one of the richest communities in the world. Such an exercise would be immediately rejected by those with even the most rudimentary grasp of mathematical analysis – and yet this is exactly the manipulation performed by the NJH author(s). The author(s) of this report have taken two data points of dissimilar entities from a lognormal distribution and "averaged" the values.

Therefore, where the author(s) took two samples, and one result was 245 spores/m3 (representing 2.45 rupees) and the second - for the exact same area - was 134,000 spores/m3 (representing 1,340.00 US dollars), the NJH author(s) reported an "average" spore concentration of 48,454 spores/m3 even though the spore profiles would have been

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[38] Sherwood RJ *On the Interpretation of Air Sampling for Radioactive Particles Health Physics and Medical Division Atomic Energy Research Establishment*, Presented at the AIHA Conference in Philadelphia, 1964 and appearing in its peer reviewed form in J of AIHA Vol. 27, pp 98-109 (1966)

[39] Phinney DE, Newman JE, The Precision Associated with the Sampling Frequencies of Total Particulate at Indianapolis, Indiana JAPCA, 22, 9, (1972)

[40] 15 Spurgeon, J; Data submitted to the ASTM D22.08.02 Committee for review, October 2005

[41] Connell, CP, *Sample results: What do they really tell us?* Presented at the IAQ in Schools Lecture Series, Corpus Christi, TX, 2003

[42] Eudey L, Su HJ, Burge HA. *Biostatistics and bioaerosols*. In Bioaerosols, Burge HA, ed. Boca Raton: Lewis Publishers, pp. 269-307. 1995.

[43] Reponen T, Nevalainen A, Jantunen M, et al, N*ormal Range Criteria for Indoor Air Bacteria and Fungal Spores in a Subarctic Climate*; Indoor Air, 2:26-31 (1992). Referenced by Macher JM, Chatigny MA, Burge HA. Sampling airborne microorganisms and aeroallergens. In: Cohen BS, Hering SV, eds. Air sampling instruments for evaluation of atmospheric contaminants, 8th ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 589-617, but not reviewed by this author (Connell).

enormously different (dollars to rupees), and in fact, entirely unknown. This type of "averaging" has exclusively been used in this NJH report.

Consider the following actual spore data from the interior of a home that never had a water intrusion problem or a marijuana grow operation:[44]

Sample Time	Spore Concentration Spore/m3
7:00	20,440
9:45	920
11:45	2,293
14:45	5,693
17:30	893
21:45	2,187

Table 2
Typical Indoor Spore Distribution

The data exhibit the anticipated lognormal distribution.[45] If the NJH author(s) had been studying this property, and collected a spore trap sample at seven in the morning, and again at 5:30 p.m., they would have averaged the results and reported, 10,667 spores/m3. However, since the data exhibit an expected lognormal distribution, we see that two samples cannot properly characterize the home's spore loading. When we collect at least six samples, we now have enough data to estimate the distribution of the counts and determine the distribution is lognormal. As such, it would not be appropriate to use an arithmetic mean, but it would be appropriate to use a statistic called the "minimum variance unbiased estimate" (MVUE). When we calculate the MVUE, we see that the actual anticipated "average" count for the home is 4,843 spores/m3. In the NJH document, the author(s) failed to use acceptable sampling practices, and failed to use basic statistical analysis, and as a result the reported data is skewed and meaningless.

The situation is even more complicated by the fact that the authors had several calculation mistakes while attempting to average two numbers. For example, in the above example, NJH reported the average of 245 spores/m3 and 134,000 spores/m3 as 48,454 spores/m3 when in fact, the average is 67,122 spores/m3. When just looking at the reported indoor averages for just one table, (Table 3), and allowing for common rounding errors, we see that fully one third of the reported averages were not calculated correctly.

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[44] Connell CP, *Sampling Strategies and Data Interpretation* presented at Property Care Association Lecture Series, Huntingdon, England November 15, 2011 (spore trap Air-O-Cell data collected from home interior by the author, February 2002)

[45] One-tail percentage point of Shapiro-Wilk W test = 0.7880; the lognormal goodness of fit = 0.9006; Gaussian goodness of fit= 0.6759

Reported			Actual Average	Correctly Calculated?
Low	High	Average		
70	140	102	105	Yes
139	175	157	157	Yes
84	274	179	179	Yes
189	369	279	279	Yes
323	344	334	334	Yes
465	512	489	489	Yes
471	597	534	534	Yes
505	745	645	625	Yes
716	850	783	783	Yes
780	1020	900	900	Yes
365	1490	863	928	No
345	2090	958	1218	No
653	2880	1893	1767	Yes
2010	2990	2500	2500	Yes
766	5210	2988	2988	Yes
2670	4020	3345	3345	Yes
1380	7610	1380	4495	No
5130	9820	6868	7475	No
10100	11500	10800	10800	Yes
893	25200	11196	13047	No
1960	45700	18020	23830	No
245	134000	48454	67123	No

Table 3
Reported Averages and Actual Averages

Furthermore, where the authors had only one sample, they used that one datum and declared it an "average" result. It is difficult to have confidence in the presentation of complex data, when the authors were incapable of simply averaging two numbers.

Reported Spore Concentrations

Ignoring the calculation errors, and assuming for argument's sake that the type of "averaging" used by NJH was valid, NJH reported finding an average[46] "total" spore count inside the marijuana grow operations of 5,144 spores/m3, and an average[47] of 1,991 colony forming units per cubic meter of air (CFU/m3) for the culturable samples. If we look at the outdoor spore concentrations reported from around the country on September 17, 2012, as presented in Table 1, we find that the normal spore

[46] N= 58; Mean = 5,144; standard error =2,439; standard deviation 18,578

[47] An arithmetic average of the reported averages.

concentrations in fresh healthy air were well above that level. Furthermore, normal, ordinary clean outdoor spore concentrations may exceed 200,000 spores/m3.[48]

Based on the NJH data, the kinds of spore concentrations reported by the NJH author(s) are found in normal, healthy, everyday residential houses across the country on a daily basis. Furthermore, on a daily basis, across the US and across the world, occupational exposures to molds and mold spores in agricultural industries are much higher[49] than those reported by the NJH author(s); and yet even those exposures are generally regarded as safe.

Mold Spore Concentrations in the Outdoor Air

Although NJH reports their values as justification for identifying the results as indicating "hazardous" levels, we find that normal, fresh, clean (safe) outdoor air spore counts are usually very much higher than the spore concentrations reported by the NJH team in the marijuana grow operations study.

Whereas NJH reported an average of 5,144 spores/m3, normal fresh outdoor air in February in New Orleans has been reported to be as high as 81,000 spores/m3.[50] British outdoor levels are similar, and one researcher[51] reported averages of 9,500 spores/m3 with hourly averages exceeding 90,000 spores/m3. Outdoor concentrations in normal non-occupationally related outdoor tropical air has been reported as high as 200,000 spores/m3.[52] It stands to reason, that a resident in these areas, who opens their windows for a nice cool breeze will be exposed to those spore concentrations.

Therefore, if the NJH author(s) would recommend respiratory protection for first responders who are exposed to 5,144 spores/m3, would the NJH team similarly recommend respirators for citizens going for a stroll in the open air in Springfield, Missouri (16,587 spores/m3) or downtown Plano, Texas (9,767 spores/m3)? If not, then why not?

In fact, none of the ambient samples collected in indoor marijuana grow operations by the NJH team were particularly elevated, and could be similar to those samples collected from a normal occupied house; even the single "elevated" sample reported by NJH could be seen during house-hold operations such as carpet removal or renovation activities.

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[48] Levetin E. *Fungi* (Chapter 5, p.99 Bioaerosols), Burge HA Editor, 1995

[49] Levetin E. Fungi (Chapter 5, p. 106), *Bioaerosols*, Burge HA Editor, 1995

[50] National Resources Defense Council

[51] Allitt U, Identity *of Airborne Hyaline One-Septate Ascospores and Their Relation To Inhalent Allergy* Transactions of the British Mycological Society 87 (1), 1986. Page 147

[52] Lacey J. *Aerobiology and health: the role of airborne fungal spores in respiratory allergy diseases*. In: Hawksworth DL, editor. Frontiers in Mycology. Wallingford: CBA; 1990 (referenced in Burge HA *Bioaerosols*, p.110, 1995, Lewis Publishers).

In their paper, the NJH author(s) attempt to make a case for the presence of *Penicillium* (although they misspell the word in their report). For reasons not explained by the authors, the NJH author(s) believe *Penicillium* was some kind of special or particularly hazardous organism. In fact, *Penicillium* is present in every single residence and structure in the US and Canada and Great Britain - without exception. *Penicillium* is one of the most common genera present on the Planet Earth, and daily, humans across the globe breathe thousands to tens of thousands of spores from this organism. During the latter part of the summer of 2007, the prestigious *International Union of Toxicology* held an *International Congress of Toxicology* meeting in Montreal, Canada. During that congress, the authors of one of the papers presented[53] reported that by merely dropping a single moldy lemon into the trash, the resulting human exposure to *Penicillium* was 286,755 spores/m3 (almost 7,000% greater than the total average ambient concentration reported by NJH). Should we conclude then, that if a first responder locates a moldy lemon in the Fire House refrigerator, they should don safety equipment or contact an hazardous waste contractor to safely dispose of the lemon? If not, why not?

Even good, clean, open meadows exhibit spore counts massively higher than that reported by the NJH team; for example, some researchers[54] reported that open fields they studied contained over one *million* spores per cubic meter of air (1,024,734 spore/m3). Yet, the cognizant medical and occupational health agencies are not recommending that farmers entering nice clean meadows wear respiratory protection, but why not? If, as reported in the NJH study, 5,144 spores/m3 constitutes an health hazard, then why are these massively higher exposures considered by the world's health organizations to be acceptable?

If we look at National, state or medical organizations, we see that the "hazardous" values reported by NJH are neither "hazardous" nor even remarkable. For example, one such source for interpreting spores counts can be found with the Delaware Department of Natural Resources and Environmental Control[55] which classifies mold spores for people who are already allergic to molds in general levels of concern as follows:

[53] Chan CY, Robbins CR, Fallah P, Hardin BD, Kelman BJ, *Risk From Inhaled Mycotoxins From Mold-Infested Produce*, IUTOX ICT—Montreal, Canada (July 15-19, 2007) Abstract #PT6.105

[54] Smith JD, Lees FT, Crawley WE; *Facial eczema on long and short herbage*, New Zealand Journal of Agricultural Research, 6:6, 518-525 (1963)

[55] Delaware Department of Natural Resources and Environmental Control, 89 Kings Hwy Dover, DE 19901 Mold Count Chart: http://apps.dnrec.state.de.us/Pollencount/PollenCount.aspx June 28, 2012

Total Spore Count/m3	Classification	Allergy sufferers who are allergic to these molds may experience symptoms of hay fever
0	Absent	No Symptoms
1- 6,499	Low	Only individuals extremely sensitive to these molds will experience symptoms
6,500 - 12,999	Moderate	Many individuals sensitive to these molds will experience symptoms.
13,000 - 49,999	High	Most individuals with any sensitivity to these molds will experience symptoms.
50,000	Very High	Almost all individuals with any sensitivity at all to these molds will experience symptoms. Extremely sensitive people could have severe symptoms.

Table 4
American Academy of Allergy and Immunology Levels of Concern

If we insert the average spore concentration reported by the NJH team, we see that 5,144 spores/m3 is largely mundane and classified as "LOW" and not much of a concern even for those individuals with allergies.

In fact, the values represented above are also the same values that are referenced nationally by the American Academy of Allergy and Immunology. Therefore, even for individuals who are sensitive to mold spores, the levels reported by the NJH team are not even considered to be high, let alone "hazardous."

In their report, the NJH author(s) warn the reader that:

> Airborne levels of mold spores within these structures may subject the occupants, emergency personnel and other individuals to significant health hazards. Persons residing in these homes are likely to have levels of exposure that can cause *hypersensitivity pneumonitis*, allergic rhinitis, asthma, and other respiratory diseases.

Yet, scientific and medical literature are at odds with the conclusions of the NJH. For example we see in the literature:

> Very rare and almost exclusively occurring in the workplace is hypersensitivity pneumonitis which is generally produced by repeated exposure to very high concentrations of spores (1,000,000 spores/m3 to 100,000,000 spores/m3); which cannot be expected to occur in residential indoors.[56]

[56] CP Connell's translation from the original German Guide: The prevention, investigation, evaluation and rehabilitation of mould growth indoors; Created by the Indoor Air Hygiene Commission of the Federal Environmental Agency

Occupational Exposures to Mold Spores

In their report, the NJH author(s) indicate that as the marijuana plants were disturbed by the first responders, the mold spore concentrations became "*extremely high*" and so too increased the responder's exposure risk:

> In some instances the levels of Penicillum (*sic*) /Aspergillus spores reached extremely high levels (greater than 100,000 spores/cubic meter) that are not normally observed in residential samples. These high levels of spores may impart an even greater risk for exposed individuals.

So, is 100,000 spores/m3 of air "extremely high"? Across the nation, and across the globe, employees involved in agricultural businesses are exposed to millions of mold spores per day.

Consider for a moment that US employees working at lumber mills[57] are daily exposed to mold spore concentrations in the *millions* of spores/m3, ranging from 1,000,000 spores/m3 to 100,000,000 spores/m3 daily; shepherds in outdoor sheep paddocks[58] are exposed to mold spores in excess of 300,000 spores/m3; human exposures on normal healthy farms[59] can be millions of times greater than those "hazardous" levels reported in the NJH study; as high as 1,200,000,000 spores/m3 (that is one point two *billion* spores per cubic meter of air). In the cited Malmberg (1993) article, the author(s) point out that these farms were selected by the Respiratory Division, National Institute of Occupational Health, (Sweden) precisely because there were **no** reported illnesses from those locations.

However, even those extremely elevated concentrations are not the highest found in the literature; other authors[60] reported finding even higher spore counts, in excess of 10,000,000,000 spores/m3 (that's ten *billion* spores per cubic meter of air) on farms. The "extremely high" occupational exposures reported by the NJH team (a mere 100,000 spores/m3) pale in comparison to the normal daily (safe) occupational exposures experienced throughout the United States, Canada, Britain and other cognizant Western cultures.

Throughout this review, we will address other types of occupational exposures to indoor molds.

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[57] Gots RE, M.D., Ph.D. (International Center For Toxicology And Medicine), *The Medical Aspects Of Mold Litigation*, presented to the ASTM International Johnson Conference, University Of Vermont, July 13, 2009.

[58] Smith JD, Crawley WE, Lees FT, *Seasonal variation in spore numbers of Pithomyces chartarum in 1960 and 1961 in the Waikato*, New Zealand Journal of Agricultural Research, 4:5-6, 538-551 (1961)

[59] Malmberg P, Rask-Andersen A, Rosenhall L, *Exposure to Microorganisms Associated With Allergic Alveolitis and Febrile Reactions to Mold Dust in Farmers*, Chest No. 103 Vol. 4 (1202-1209) April 1993

[60] Karlsson K, Malmberg P, *Characterization of exposure to molds and actinomycetes in agricultural dusts by scanning electron microscopy, fluorescence microscopy and the culture method*; Scand J Work Environ Health 1989;15:353-359

SIGNIFICANCE OF GENUS AND SPECIES

Stachybotrys

In the NJH report, the author(s) state:

> Two types of plates were utilized, malt extract plates for general molds and DG-18 plates for Stachybotris (*sic*) sp.

This statement creates two problem for the NJH author(s) since there is no such organism known as "Stachybotris" and so at this point, we don't know if the author(s) meant to reference the fungal rot known as "*Botrytis*" (Family Sclerotiniaceæ), or did the NJH author(s) try to refer to the genus "*Stachybotrys"*(a deuteromycete fungus in the Family Dematiaceæ)? The second problem is that the NJH author(s) never explain why they sampled for this organism (assuming it was "*Stachybotrys*"), never mention it again in their paper, never provided the results of their "Stachybotris" measurements, and never explained why they selected an agar plate for this organism.

We presume the author(s) were trying to refer to the genus "*Stachybotrys"* since this organism is the dreaded "toxic black mold" of science fiction fame; frequently used by confidence tricksters to frighten home owners out of thousands of dollars in unnecessary mold "remediation" projects. However, in general, given the nutritional requirements for *Stachybotrys*, we would not expect to find significant *Stachybotrys* colonization in marijuana grows, simply because the marijuana plants are not particularly well suited as hosts for this organism, which has specific nutritional needs that are not associated with growing plants.

In fact, this infamous "toxic black mold" presents no greater health threat than does any other common indoor mold. Legitimate Industrial Hygiene and medical literature discusses this organism in great detail and contains quotes such as the following:

> *...years of intensive study have failed to establish exposure to* S[tachybotrys] chartarum *in home, school, or office environments as a cause of adverse human health effects.*[61]

And:

> *No convincing cases of human allergic disease or infection from this mold* [Stachybotrys] *have been published. …The current public concern for adverse health effects from inhalation of Stachybotrys spores in water-damaged buildings is not supported by published reports in the medical literature.*[62]

And:

> *A critical review of papers, reports, and studies on* Stachybotrys *mycotoxins revealed only descriptive reports of suspected animal and human poisoning secondary to*

[61] Hardin, B.D., Kelman B.J, Saxon, A. *Adverse Human Health Effects Associated with Molds in the Indoor Environment* Peer-reviewed by the Council and its committees, and approved on October 27, 2002.

[62] Terr, A. I. Stachybotrys: *relevance to human disease* Annals of Allergy Asthma and Immunology (87, Supp l: 57-63), 2001

> *consumption of mold contaminated foods. No studies of good toxicologic and epidemiologic designs answer whether airborne mycotoxins produced by* Stachybotrys *could produce specific human toxicity.*[63]

And:

> *While many papers suggest a similar relationship between* Stachybotrys *and human disease, the studies nearly uniformly suffer from significant methodological flaws, making their findings inconclusive. As a result, we have not found supportive evidence for serious illness due to* Stachybotrys *exposure in the contemporary environment.*[64]

This "toxic black mold" is often exploited by poorly trained "certified mold inspectors" who are quick to point out that the organism was identified by the US Centers for Disease Control as being the "toxic black mold" that killed 13 children in Ohio.[65]

However, those same individuals are very slow to recall that the original CDC report was heavily criticized by the global scientific and medical communities and, as a result, the US Centers for Disease Control withdrew the report after it had convened two independent international committees to review the initial report and concluded:[66]

> *Both groups of reviewers concluded that the available evidence does not substantiate the reported epidemiologic associations—between household water damage and AIPH or between household fungi and AIPH —or any inferences regarding causality.*

When we look at legitimate medical and occupational literature, we find that the spore concentrations associated with *Stachybotrys* necessary to cause adverse health effects are millions of times greater than the spore concentrations reported by the NJH team – even if ALL the spores reported by this NJH study belonged to the genus "*Stachybotrys*."

We see for example, that the normal daily exposures to *Stachybotrys* in a greenhouse potting shed are reported in literature[67] as high as 7,500 spores per m3. In this operation, there were no reported illnesses associated with the *Stachybotrys*.

Some of the toxic compounds in molds that make them "toxigenic" (not "toxic" as commonly reported in the press) are called "mycotoxins." Mycotoxins, like other toxic

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[63] Fung F, Clark R, Williams S, Stachybotrys, *a Mycotoxin-Producing Fungus of Increasing Toxicologic Importance*; Clinical Toxicology 36 (1&2)79-86, 1998)

[64] Kuhn, DM, Ghannoum MA; *Indoor Mold, Toxigenic Fungi, and* Stachybotrys chartarum*: Infectious Disease Perspective* Clinical Microbiology Reviews, Vol 16, No 1, Jan 2003, pp. 144-172

[65] Dearborn DG, et al. Acute Pulmonary Hemorrhage/Hemosiderosis Among Infants — Cleveland, January 1993–November 1994. MMWR December 09, 1994 / 43(48);881-883

[66] Update: Pulmonary Hemorrhage/Hemosiderosis Among Infants — Cleveland, Ohio, 1993–1996 Morbidity and Mortality Weekly Report, Centers for Disease Control, Vol. 49, No. 9, March 10, 2000

[67] Dill and Trautmann *Massenentwicklung von* Stachybotrys chartarum *auf kompostierbaren Pflantztöpfen aus Altpapier* Mycoses 40 (Suppl 1) p. 110-114, (1997) – translated from the original German by this reviewer, Connell

materials and hazardous substances, follow standard and accepted toxicological parameters; there is nothing new or special about molds or their mycotoxins.

All substances exhibit a toxicological level below which an exposure will not result in any known adverse health effect. Toxicologically, this is known as the "Lowest Observable Adverse Effect Level" (LOAEL). It turns out that even in extremely moldy houses containing massive exposures to indoor molds, authors have reported that the mycotoxin concentrations are nevertheless millions of times lower than that needed cause any illnesses.

For example, Brasel, Martin *et al*[68] studied residences that had been heavily damaged by flood waters, and in which there were huge fungal blooms of mold throughout the homes (up to 500 square feet of mural mold growth on the walls). The researchers confirmed that *Stachybotrys* concentrations were in the order of 16,000 spores/m3. Yet, even in these heavily contaminated houses, the daily dose of mycotoxins (expressed as total trichothecenes) was 8.9E-10 below the LC50[69] reported by Wannemacher[70] (that is (89,000,000,000 times less than the LC50) and 5.9E-6 below (5,900,000 times below) the LOAEL[71] reported the by the European Commission Health & Consumer Protection Directorate-General.[72] That is, where trichothecenes were measured even in extremely contaminated properties, the daily dose from the mycotoxin was 168,000 times lower than the dose needed to induce an adverse physiological effect in the animal model used in the study.

We do not know why the NJH team singled out "Stachybotris" *(sic)* since the author(s) never mention it again after stating they wanted to measure it: however, we do know that even if the values reported in this NJH study were valid, and even if the results exclusively represented *Stachybotrys*, the concentrations reported in this study are millions of times lower than that needed to induce health hazards, as discussed extensively in peer reviewed scientific and medical literature.

At the heart of the matter, an indoor marijuana grow operation is an agricultural business – the operator is growing plants. Much like a greenhouse operation growing tomatoes,

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[68] Brasel TL, Martin JM, Carriker CG, Wilson SC, and Straus DC; *Detection of Airborne* Stachybotrys chartarum *Macrocyclic Trichothecene Mycotoxins in the Indoor Environment* (Applied And Environmental Microbiology, Nov. 2005, p. 7376–7388)

[69] Lowest Concentration in air needed to kill 50% of the test organisms used in the study.

[70] Wannemacher RW, Wiener, SL, Chapter 34, TRICHOTHECENE MYCOTOXINS; in Medical Aspects of Chemical and Biological Warfare, Textbook of Military Medicine Published by the Office of The Surgeon General Department of the Army, Zajtchuk R, Editor in Chief, Bethesda, Maryland, 1997

[71] Lowest Observable Adverse Effect Level

[72] European Commission Health & Consumer Protection Directorate-General *Opinion of the Scientific Committee on Food on Fusarium toxins. Part 6: Group evaluation of T-2 toxin, HT-2 toxin, nivalenol and deoxynivalenol* (SCF/CS/CNTM/MYC/27 Final 27 February 2002)

roses, or indeed herbs and spices used for food processing, the operation involves growing plants indoors. At its worst, the NJH report found spore concentrations in marijuana grow operations that are remarkably lower than most other agricultural businesses and even lower than spore concentrations first responders and police officers will receive by simply sanding outside their offices in the fresh clean air; and the NJH author(s) failed to make a scientifically valid claim that the exposures they reported were hazardous.

The Penicillia

The NJH author(s) also focus on the genus *Penicillium*. Again, the NJH author(s) misspelled the name of the genus throughout their report and failed to explain why they were concerned about this ubiquitous mold that is found in every house on Earth.

Saying that one found *Penicillia* in a residence is rather like saying one found "air" inside an home. It is rather what one would expect to find. As mentioned earlier, recently some authors reported[73] that by merely dropping a single moldy lemon into the trash, the resulting human exposure to *Penicillium* was 286,755 spores/m3.

The author(s) of the NJH report never explained why they were so concerned about this normal, everyday, ordinary indoor mold to which every American, everyday inhales hundreds to thousands of spores.

SAMPLING

The NJH author(s) failed to use scientifically valid assessment protocol capable of producing exposure data. The "sampling" methods employed by the NJH team were the same as those commonly used by poorly trained "toxic mold" practitioners to frighten home owners, but are otherwise invalid.

It is a well known, and scientifically accepted fact that air sampling for spores performed at any one time will be applicable only for that moment in time,[74] and even if performed correctly, only for the day during which the sampling occurred. The next day, the results of such testing *will* be completely different. As explicitly explained by the US EPA, even if legitimate sampling is conducted…[75]

> *Keep in mind that air sampling for mold provides information only for the moment in time in which the sampling occurred, much like a snapshot. Air sampling will reveal, when properly done, what was in the air at the moment when the sample was taken. For*

[73] Chan CY, Robbins CR, Fallah P, Hardin BD, Kelman BJ, *Risk From Inhaled Mycotoxins From Mold-Infested Produce*, IUTOX ICT—Montreal, Canada (July 15-19, 2007) Abstract #PT6.105

[74] Morris G, Kokki M, *Methods for Sampling Aspergillus spores in air*, Journal of Hospital Infection (2000) 44:81-92 September 1999

[75] United States Environmental Protection Agency "*Mold Remediation in Schools and Commercial Buildings*" EPA 402-K-01-001 March 2001 (updated 6/25/01)

> *someone without experience, sampling results will be difficult to interpret. Experience in interpretation of results is essential.*

Therefore, any sampling that is done is valid for that instant in time, and is no longer valid even one hour later or one day later and at no time thereafter. This is a basic known consideration found throughout published literature.

Classic Industrial Hygiene sampling strategy indicates that reasonable confidence in estimating an average ambient airborne concentration is achieved when at least 70% of the exposure time is measured,[76] and states that random "grab samples" (such as those collected by NJH at the subject properties) are the least desirable technique for estimating the average exposures.[77]

The total sampling time used by the NJH team for the spore traps represents only about 1% of the anticipated occupancy time of the residence occupants and less than 10% of the anticipated exposure time for law enforcement personnel processing the site. This error is known as the "sampling design error," and, if uncharacterized, produces huge uncertainties in the reported results.

Indeed, one researcher notes:[78]

> *The requirement to present an integrated assessment of exposure* [to airborne spores] *implies that the sampling period should be long, perhaps hours or days.*

If grab samples, such as the spore traps collected at the studied marijuana grow operations are used, accepted classic Industrial Hygiene references[79,80] have estimated that for each daily study period (usually expressed as any eight hour period for a work place or 12 hours for a residential setting) between eight and eleven random grab samples are needed *from each study area* (each bedroom, each foyer, each control area, each living room, etc.), to obtain adequate confidence in determining the variance associated with the study area for just that one day alone. The next day, or any time thereafter, an additional eight to eleven random grab samples are needed *from each study area.* This principle is a basic, foundational principle of air sampling.

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[76] NIOSH Occupational Exposure Sampling Strategy Manual, HEW Publication Number 77-173 (1977)

[77] Ibid.

[78] Mo Morris G, Kokki M, *Methods for Sampling Aspergillus spores in air*, Journal of Hospital Infection (2000) 44:81-92 September 1999

[79] NIOSH Technical Information Exposure Measurement Action Level and Occupational Environmental Variability, HEW Publication 76-131, Cincinnati OH, 45226, (1975)

[80] NIOSH Occupational Exposure Sampling Strategy Manual, HEW Publication Number 77-173 (1977)

If we look at actual NIOSH recommendation protocols for comparing indoor to outdoor samples, we see that NIOSH also explicitly states:[81]

> *Select at least three sites, one each to represent complaint area, a noncomplaint area and outdoors.*
>
> *In turn at each site, sample simultaneously for fungi, mesophilic bacteria, and thermophilic actinomycetes.*
>
> *Before moving to the next site, repeat twice to obtain triplicate, consecutive samples.*
>
> *Collect another complete set of samples and blanks on the next day.*

Therefore, at the end of the sampling period, in order to compare indoor and outdoor samples, the consultant would have collected six samples for fungi, six samples for mesophilic Bacteria, and six samples for thermophilic actinomycetes from the study area; and six samples for fungi, six samples for mesophilic Bacteria, and six samples for thermophilic actinomycetes from an indoor control area, and six samples for fungi, six samples for mesophilic Bacteria, and six samples for thermophilic actinomycetes from the outside. However, the NJH author(s) used a sampling protocol that was never identified and not supported by science.

The NJH team did not follow validated methodology and merely collected two meaningless slit impaction spore traps and some Andersen samples from inside grow operations and two meaningless spore traps from outside, and claimed without support, they could compare two unreliable moving targets with massive errors, --and even more remarkably --even though the two samples exhibited huge differences, indicating a lognormal distribution, the authors ignored basic mathematical analysis and "averaged" the results.

These NJH author(s) stated that they were performing the study to determine appropriate personal protection equipment for law enforcement under certain circumstances. However, not only did the NJH author(s) fail to accomplish that goal, but, regarding indoor molds, the US Centers for Disease Control[82] *Mold Work Group*, in its section "Chapter 2: Assessing Exposure to Mold" states (in part):

> *Sampling for mold is **not** part of a routine building assessment. In most cases appropriate decisions concerning remediation and need for personal protection equipment (PPE) can be made solely on the basis of visual inspection.* (sic)

[81] NIOSH Method 0800, BIOAEROSOL SAMPLING (Indoor Air) Culturable organisms: bacteria, fungi, thermophilic actinomycetes, Issue 1, January 1998

[82] The CDC Mold Work Group, National Center for Environmental Health, National Center for Infectious Diseases, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, October 2005

The CDC recognized the frivolity of the common types of mold sampling as being used by today's "mold practitioners" in the same document when it stated:[83]

> *Other than in a controlled, limited, research setting, sampling for biological agents in the environment cannot be meaningfully interpreted and would not significantly affect relevant decisions regarding remediation, reoccupancy, handling or disposal of waste and debris, worker protection or safety, or public health.*

Regarding the NJH author(s) allusions to "hazardous" levels of mold; in 2004, the US EPA published the "*Guidance for Clinicians on the Recognition and Management of Health Effects Related to Mold Exposure and Moisture Indoors*," which is a medical guidance document sponsored by the US EPA.[84] In that document, the authors explicitly warn physicians about the poor quality of the "testing results" they are likely to receive from various untrained consultants and warn physicians:

> *The reader should note that the authors do not advocate air sampling to initially address concerns over mold in the indoor environment. This is in part because air test results are often not representative of the biological exposures a patient may face and, therefore, can be misleading and not helpful.*

The US Environmental Protection Agency, in its booklet "*Mold Remediation in Schools and Commercial Buildings*" [85] recommends against the type of sampling performed by the NJH team; the EPA states that except in unusual circumstances, such sampling should not be performed but, if it is, then it should only be performed by a legitimate scientist, such as a qualified Industrial Hygienist, *and only if* the Industrial Hygienist has established proper sampling data quality objectives. NJH does not identify any such data quality objectives and the presentation of their data demonstrate the authors had no such DQOs.

The EPA also warns:[86]

> *Sampling for mold should be conducted by professionals with specific experience in designing mold sampling protocols, sampling methods, and interpretation of results.*

The EPA document continues with:

> *Inadequate sample plans may generate misleading, confusing, and useless results.*

---

[83] Ibid

[84] Storey E, Dangman KH, Schenck P, DeBernardo RL, et al, *Guidance for Clinicians on the Recognition and Management of Health Effects Related to Mold Exposure and Moisture Indoors*, Cooperative Agreement No. T 981255, September 30, 2004

[85] EPA 402-K-01-001 March 2001 (updated 6/25/01)

[86] Ibid.

The EPA states:

> *For someone without experience, sampling results will be difficult to interpret. Experience in interpretation of results is essential.*

…

> *Sampling should be done **only** after developing a sampling plan that includes a confirmable theory regarding suspected mold sources and routes of exposure. Figure out what you think is happening and how to prove or disprove it before you sample!*

The EPA notes:

> *Sample analysis should follow analytical methods recommended by the American Industrial Hygiene Association (AIHA), the American Conference of Governmental Industrial Hygienists (ACGIH), or other professional guidelines.*

Contrary to legitimate science and standard industry practices, the author(s) of the NJH document failed to follow any documentable sampling plan and the presentation of the results shows a lack of legitimate knowledge or experience in indoor mold related issues.

At the heart of bioaerosols investigations is the development of hypothesis testing[87] and the establishment of data quality objectives.

The methods referenced by the US NIOSH, the US EPA, US CDC, AIHA, ACGIH and others, are very much different from those used by the NJH team for the collection of "samples" at the study locations. The report did not mention why the NJH team chose to disregard established, accepted protocols and use their own newly designed "protocols"; and further never explained why they believed these protocol were valid, or how validity was confirmed or by whom.

Data Quality Objectives

In the following sections, each of the described parameters apply to both the "total spore traps" and the Andersen samplers used by the NJH team. However, the errors associated with the Andersens are even greater than the slit impactors; however such a discussion would unnecessarily extent this review.

The sampling plan(s) referenced above by cognizant organizations, is based on the establishment of data quality objectives (DQOs). Without DQOs, one does not have "data"- one has meaningless numbers on an otherwise legitimate, but entirely uninterpretable, laboratory report. That is, the laboratory report may be a legitimate laboratory report from a respectable analyzing laboratory, however the data on the report is not interpretable. Contrary to TV shows such as "CSI," laboratory reports have no intrinsic meaning; the data on a laboratory report has no significance beyond the investigator's written data quality objectives and hypothesis testing – in this case, the NJH team documented having neither.

[87] Burge HA *Bioaerosols*, Lewis Publishers, 1995

At the heart of any exposure sampling data are the DQOs established by the investigators. Several standard industry practice manuals identify DQOs and their application in environmental sampling and site assessments. US EPA SW846 document[88] is geared toward environmental sampling. The sampling precepts and the QA/QC[89] foundations are recognized as being applicable to all kinds of sampling. The SW 846 describes DQOs thusly:

> *Data quality objectives (DQOs) for the data collection activity describe the overall level of uncertainty that a decision-maker is willing to accept in results derived from environmental data. This uncertainty is used to specify the quality of the measurement data required, usually in terms of objectives for precision, bias, representativeness, comparability and completeness. The DQOs should be defined prior to the initiation of the field and laboratory work. The field and laboratory organizations performing the work should be aware of the DQOs so that their personnel may make informed decisions during the course of the project to attain those DQOs.*

The EPA document identifies the foundation of the sampling plan as: *precision, bias, representativeness, comparability and completeness.* These are known as the "PARCC" parameters and are more typically given as: Precision, Accuracy (includes bias), Representativeness, Comparability, and Completeness).

Precision

Precision of a result speaks to the confidence one has of the result, and the error associated with that result. Precision asks, "If I repeat the test, will I get the same result?" If one gets the same result over and again, the precision is said to be "good."

If a 150 pound man steps onto a bathroom scale six times in a row, he is very likely to see that the scale roughly reproduces the same reading all six times; that is, the scale is reasonably *precise*. The scale may be *inaccurate*, but if it gives the same reading over and over again, it is *precise*. Now imagine that the man steps onto the bathroom scale six times and observes the following readings:

200 pounds
91 pounds
143 pounds
73 pounds
31 pounds
86 pounds

That man will have no *confidence* in any single reading because the bathroom scale is neither accurate nor precise. Therefore, if the man steps on the scale and it shows he

[88] US EPA *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, 1996 (This is the EPA OSW's official compendium of analytical and sampling methods that have been evaluated and approved for use in complying with the RCRA regulations.)

[89] Quality Assurance / Quality Control

weighs 257 lbs. (which is within the confidence limits given above), [90] based on that reading, would it be wise for him to conclude he is overweight and needs to begin a diet? Of course not, because the next time he steps on the scale it could indicate that he only weights 31 pounds and is desperately in need of food. In other words, the reading on the bathroom scale cannot be used for any decision making because it lacks precision (and accuracy).

And yet, this is exactly the kind of precision (and accuracy) associated with the spore concentrations reported by the NJH author(s) in their document. In fact, the values used in the above example are decimals of actual spore trap sample results taken from a normal, clean, ordinary, healthy, dry Colorado home which did not have a marijuana grow or a mold problem and all the air samples were collected from the same study area within the home. Here are the actual spore trap results: [91]

2,000 spores/m3
912 spores/m3
1,429 spores/m3
728 spores/m3
309 spores/m3
857 spores/m3

The data exhibit the standard, expected variability associated with any kind of spore trap samples collected by anyone at any location; known as "lognormal distribution."[92]

The above values are just for normal undisturbed air within an home. It is a well established fact that mechanical disturbance and activity within a home will significantly increase the overall spore concentrations.[93] Therefore, the "data" from the times when the indoor marijuana areas were being disturbed could easily be similar to any other normal, clean, residence during similar disturbances even when no marijuana operations are present (such as during a "moving day" or spring-cleaning or even during carpet vacuuming).

Contrary to what is proffered by the NJH author(s), their two separate samples simply cannot be used to represent the spore concentration for a given area. The argument is

[90] The example spore trap results above were collected from an healthy control home in Colorado. The Shapiro-Wilk W test point is 0.7880, Goodness of fit for Gaussian distribution is 0.9470 and lognormal is 0.9543. Lognormal skew is -0.6513. The MVUE ("average") spore count is 1,052 spores per cubic meter of air. The 95% confidence interval is from 697 spores per cubic meter of air to 2,574 spores per cubic meter of air.

[91] Collected by this reviewer (Connell) from inside a normal, clean, healthy, dry Colorado home in June.

[92] One-tail percentage point of Shapiro-Wilk W test = 0.7880; the lognormal goodness of fit = 0.9543; Gaussian goodness of fit= 0.9470; MVUE = 1,053 spores/m3

[93] Levetin E. Fungi (Chapter 5, p. 103), *Bioaerosols*, Burge HA Editor, 1995

contrary to accepted Industrial Hygiene practices and would not be accepted for any other kind of exposure assessment in any other kind of an environment.

It has long been known by legitimate Industrial Hygienists and legitimate mold experts that the kind of air monitoring performed by the NJH team cannot confidently or reliably produce results that represent actual spore identifications OR spore concentrations. This fact has been re-established over and again in legitimate peer-reviewed journals in the scientific world (as are referenced throughout this critical review.)

In fact, had the NJH team placed ten identical samplers within the study grow room and collected ten identical samples at exactly the same time, from exactly the same location and submitted those samples to the same laboratory, they would have seen ten completely different sample results; the spore counts would be wildly different and even the types of organisms identified would be wildly different[94] (see the discussion on "Accuracy," below). Yet, each sample would have come from the exact same room at the exact same time. Where such studies have been performed, side-by-side collocate apparatuses are built which allow several sets of simultaneous side-by-side samples:

Photograph 1
Side-by-side Sample Assembly[95]

[94] Connell CP, *Field Measurements for Moulds: Spatial and Temporal Variations*, Presented at the ASTM International Conference: Bringing Science to Bear on Moisture and Mold in the Built Environment, Colorado University, Boulder 2006

[95] Assembly used by this reviewer (Connell) in field research (see following data).

When one collects such instant side-by-side samples, we see that even if two spore trap samples are simultaneously collected and are collected within only a matter of inches apart from each other, the results are completely different, and the two samples cannot be compared (see the figure below):

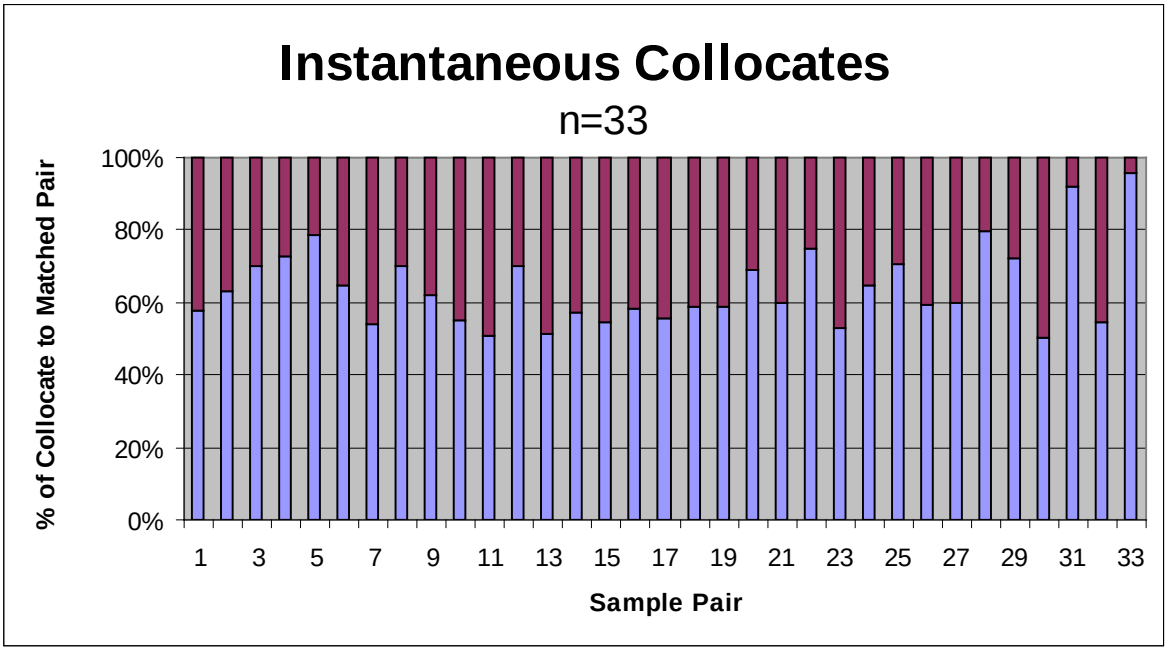

Figure 5
Comparison of Side-by-side Simultaneous Spore Trap Samples[96]

If we look at simultaneous collocates that include Andersen sampling, we see that the comparisons become even worse (to maintain scale, we have exhibited two ranges below from 1 spore/m3 to 500 spores/m3 and from 501 spores/m3 to 5,000 spores/m3).

[96] Connell CP, *Sampling Strategies and Data Interpretation*, Environmental Information Association, March, 2010 - Austin, TX

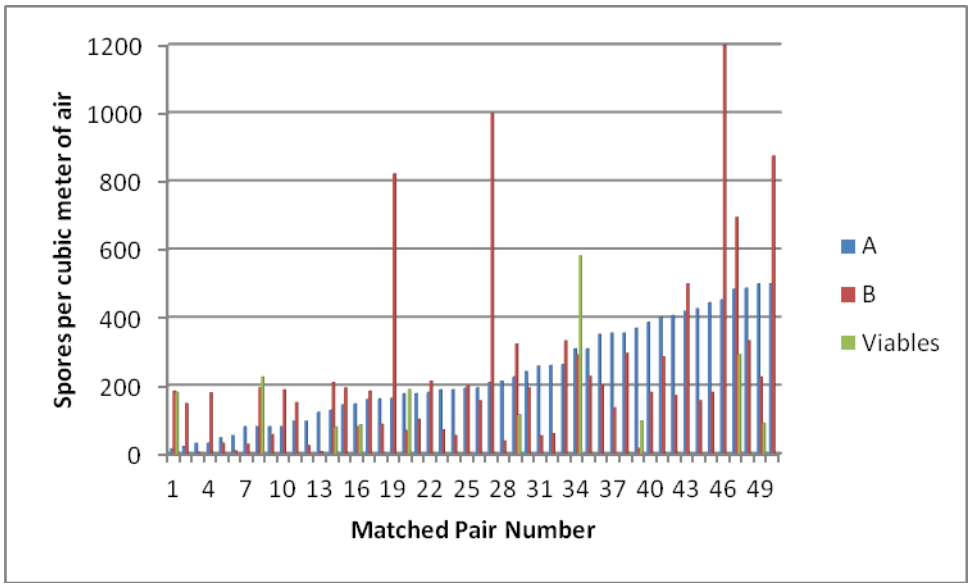

Figure 6
Comparison of Side-by-Side Simultaneous Spore Trap and Viable Samples
(From 1 Spore/m3 to 500 Spores/m3)

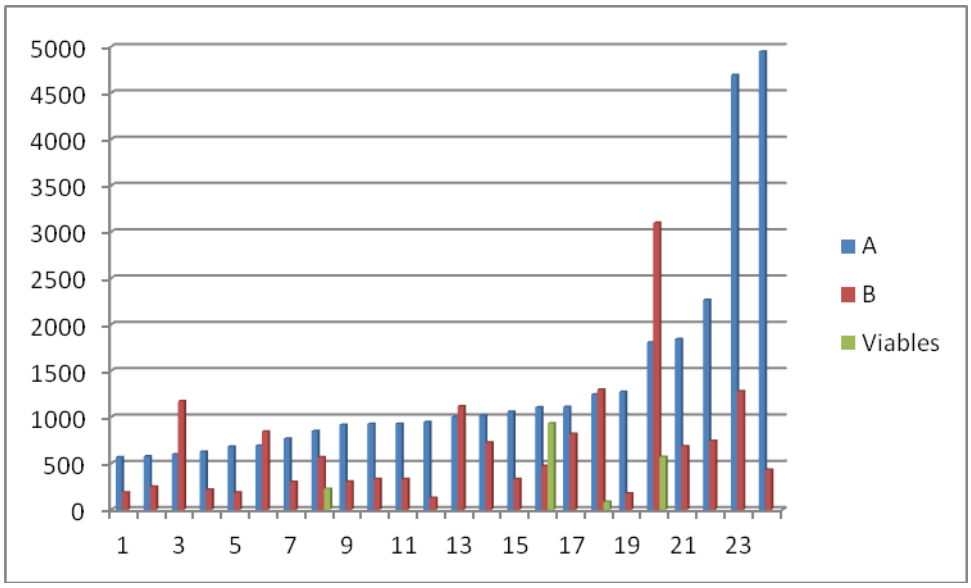

Figure 7
Comparison of Side-by-Side Simultaneous Spore Trap and Viable Samples
(From 501 Spore/m3 to 5,000 Spores/m3)

From this we know it is impossible to get good comparability between two or three samples all collected with a few inches of each other and collected at the exact same time. How then can the NJH team claim they are comparing an indoor sample to an outdoor sample when they cannot even demonstrate good comparison between two indoor samples from the same location? The NJH authors have ignored the fact that their own data indicate the error associated with their method is so high, they cannot even

confidently compare two indoor samples collected from the same room, and demonstrate confidence in the actual spore concentration.

If we look at the data presented for the "total" spore counts, we see that the error observed in the above example is not unique, but all of the data thus presented in the NJH report indicates extremely large sampling errors. In the following table, we have expressed the relative percent difference (RPD) between the "high" and "low" values reported in the NJH report – using this metric, at infinite difference between two numbers, the RPD cannot be greater than 200% (that is, once there is 200% difference between two numbers, the RPD stays at 200% regardless of how much bigger a difference may be seen).

Low Result	High Result	Relative Percent Difference
70	140	67
139	175	23
84	274	106
323	344	6
189	369	64
0	464	200
465	512	10
471	597	24
0	654	200
0	711	200
505	745	38
716	850	17
780	1020	27
0	1410	200
365	1490	121
0	1960	200
345	2090	143
0	2520	200
0	2860	200
653	2880	126
2010	2990	39
2670	4020	40
766	5210	149
1380	7610	139
5130	9820	63
10100	11500	13
893	25200	186
1960	45700	184
245	134000	199

Table 5
Relative Percent Difference Between NJH
Reported High and Low
"Total" Spore Concentrations

Generally, good reproducibility is attributed where the RPD is less than 15%. In this case, only three samples exhibited door reproducibility (that is, 90% of the data did not exhibit good reproducibility).

Therefore, how can the NJH researchers claim that they found indoor spore concentrations five times greater than outdoor concentrations, when their own data indicate that there is more than a factor of five just between their "high and low" samples for the same room? (Indeed, there is upwards to a factor of 2,860 between two indoor samples collected from the same room).

Answer: The authors cannot make the claim because the NJH researchers never actually determined the spore concentrations in the grow operations and the NJH researchers never actually determined the spore concentrations in the outdoor air. Therefore, since the NJH researchers never determine the spore concentration in indoor air or outdoor air, they cannot, with validity, claim they are making any comparison.

As already described, the spore trap samples were exclusively short-term samples. It is a well established and standard Industrial Hygiene sampling tenet that short term samples exhibit extremely large temporal variations. [97,98] This is to say that if the NJH researchers had collected ten identical samples within the same grow room, but at different times of the day or even just three minutes apart, they would end up with ten completely different sample results; the spore counts would be wildly different and even the types of organisms identified would be wildly different.

We can speak of the precision in terms of "deviation" which indicates the amount of "spread" of results about an "average" concentration (actually a "mean" concentration). In the NJH report, 20 of the 30 matched pairs had a factor of 2 or greater between the "high" and "low" spore trap; 15 of the 30 had a factor of 4 or greater; 10 of the 30 had a factor of 20 or greater; 8 of the 30 had a factor of greater than 400, and in 4 of the 30 pairs there was a factor of over 1,000 between the high and low samples for the exact same area.

So, unlike the 200 pound man who steps onto a broken scale and looks down and sees that he weighs 14 pounds, the NJH authors actually believed the bathroom scale.

Conclusion Regarding Precision:

None of the NJH data presented in the NJH document exhibited knowable or acceptable precision. The lack of precision fatally flaws this data and invalidates this data.

[97] Morris G, Kokki M, *Methods for Sampling Aspergillus spores in air*, Journal of Hospital Infection (2000) 44:81-92 September 1999

[98] Ayer HE; Burg J, *Time Weighted Averages Vs. Maximum Personal Sample* (Presented at the AIHA Conference, Boston, MA, 1973)

Representativeness

Before moving on to addressing "Accuracy," it is important to address a data quality that is similar in modality to "Precision" and that is "Representativeness."

Random Error

Going back to our example of a man on a broken scale - if we ask the question "What does the reading *represent*?" we would have to conclude the reading doesn't represent anything, and certainly doesn't represent the man's weight.

If we want to know the man's weight, even with an accurate and precise scale, we are going to have to ask an a priori question - "What are we trying to represent?"

If we want to know the man's weight over the course of his life, we cannot take a random reading, we will have to take numerous bodyweights from birth to death. If we want to know a man's weight during his second decade, we will have to take fewer readings, since we anticipate less variability during that shorter period of time. It would be inappropriate to randomly select a time in the man's life, measure his body weight and declare that that weight represents the man's body weight (after all, we could randomly end up with his weight as a one year old toddler and misrepresent that as the weight that "represents" the man).

Similarly, we want to know the exposure to mold spores in an area and we already know our spore trap methods are inaccurate and imprecise; therefore, to overcome these inherent deficiencies, we will need to collect dozens of samples to allow us to characterize the distribution and calculate the errors thus allow us to know the confidence.

However, the NJH authors did none of that.

In marijuana grow operations it would not be feasible to collect samples over the course of several days. Therefore, to minimize sampling error, it would become important to characterize representativeness by characterizing the distribution, by collecting many, many samples during the course of a single day within a single grow room.

As it is, given the huge variations seen in both the indoor and the outdoor sample results presented in the NJH report, one can legitimately ask: "Do ANY of the data collected by the NJH team represent the actual spore count?" To which the answer would be a most definite "No."

Confidence Intervals

During legitimate Industrial Hygiene sampling and testing, the Industrial Hygienist considers the degree of uncertainty associated with any particular "test" or analysis. The uncertainty is known as the total coefficient of variation (Cv_T), for each method. The Cv_T includes the uncertainty associated with both the sampling and analytical processes. For most methods, the degree of analytical uncertainty (precision) is known and published, and is generally quite small.

So, for example, if the Industrial Hygienist is studying, say, xylene in the air at about 200 parts per million (ppm), he knows that if he sent the sample to several labs for analysis, he would see a variation of results of about 195 ppm to 205 ppm. This is known as the analytical "precision" of the result. Standard Industrial Hygiene protocols typically use the 95% confidence intervals to determine the possible "spread" of the laboratory results about the true value. As such, where the Cv_T is known, the IH calculates the UCL and LCL[99] and determines if the UCL is greater than or less than the Decision Threshold being used.

In the case of the NJH study, the samples were so poorly collected, if we calculated the confidence intervals, we would see that the ranges between the UCL and LCL are so vast, one could almost just pick a value between zero and approximately 50,000 and one would have as much confidence in the guessed value as any of the samples collected.

Thus for example, if we look at the spore counts from the normal Colorado home as represented in Table 5, above, we see that the LCL[100] is 697 spores/m3 and the UCL[101] is 2,574 with a ULT[102] of over 9,500 spores/m3 (i.e. there is greater than 5% chance that any sample collected in that house will exceed 9,500 spores/m3).

None of the samples collected by NJH from the subject areas can be used to represent the exposures of first responders or spore concentrations with any confidence.

Systematic Error

All of the sampling issues described above are a type of error known as "random error." There is another type of error not yet discussed called "systematic error."

As discussed above, the precision of spore trap collection has been known for several decades to be extremely poor. However, it has also been known for decades that the systematic error associated with spore traps is so high it even further reduces the reliability of the results, making such data almost impossible to interpret. It is for this reason the US Centers for Disease Control states:[103]

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[99] The UCL, upper confidence level (or upper confidence interval) and the LCL, lower confidence level, are limits of estimates of error or variation about a probable or known mean.

[100] Land's 95% LCL

[101] Land's 95% UCL

[102] Upper tolerance limit

[103] The CDC Mold Work Group, National Center for Environmental Health, National Center for Infectious Diseases, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, October 2005

Other than in a controlled, limited, research setting, sampling for biological agents in the environment cannot be meaningfully interpreted and would not significantly affect relevant decisions regarding remediation, reoccupancy, handling or disposal of waste and debris, worker protection or safety, or public health.

In June of last year, a study was published[104] concerning the same spore counting methods used by NJH personnel in their "study" for the enumeration of spores in the air. The 2011 published study concluded what was already known: not only are the samples themselves inherently variable (as described above), but the analyzing laboratories to whom the samples are sent for analysis *cannot reliably analyze the samples* to within any reasonable degree of confidence.

The researchers focused on the ability of AIHA accredited laboratories to accurately analyze a sample with confidence. The researchers reported that for the exact same samples that were submitted to seven different AIHA accredited laboratories, the laboratories could not reproduce each other's results. Each accredited laboratory reported results that were hugely variable among themselves. Sample #1, in their "round-robin" for example, with a probable value of 540 spores/m3 was analyzed by one accredited laboratory as containing only 40 spores/m3, and yet another fully accredited laboratory issued a report stating the result of the EXACT same sample was 1,933 spores/m3 – all other laboratories fell somewhere between these two extremes.

The remaining samples in the study were no better, for Sample #3 in the study, one AIHA accredited laboratory reported 1,510 spores/m3 another equally qualified AIHA accredited laboratory reported 15,287 spores/m3 for the exact same sample.

So, it begs the question, which laboratory result is correct? Which, if any, of the NJH sample results are correct; and how would we know? In their document, the NJH researchers did not address QA/QC in any manner whatsoever, and therefore, we absolutely no idea if ANY of the data thus reported is even remotely close to representing actual spore concentrations.

In the above referenced study (Robertson) why were all seven participating laboratories "wrong" to the extent they could not reproduce each other's results? Does this information impact the reliability of making decisions based on the air "testing?"

Below, we have summarized the findings of the Robertson report and listed the ranges reported by the laboratories, each analyzing the exact same sample. The laboratories were not capable of determining the actual concentrations of spores in the air; note the large standard deviation (SD) of the counts in the following table:

[104] 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

Sample 1		Sample 2		Sample 3		Sample 4	
Reported Range	SD	Reported Range	SD	Reported Range	SD	Reported Range	SD
40 to 1,933	395	80 to 1,120	290	1,510 to 15,287	3,335	3,700 to 28,959	6,660

Table 6
Comparative Spore Concentrations[105]

Essentially, the Robertson study underscored why legitimate Industrial Hygienists don't perform the kind of sampling performed by the NJH researchers. The Robertson study also helps to explain how legitimate Industrial Hygienists are able to "guess" airborne spore counts for a given property and therefore why the US Centers for Disease Control states:[106]

> *Sampling for mold is **not** part of a routine building assessment. In most cases appropriate decisions concerning remediation and need for personal protection equipment (PPE) can be made solely on the basis of visual inspection.* (sic)

The Robertson study (referenced above) reveals that a mold researcher who was unhappy with his lab "results" could just keep resubmitting the same samples to either the same lab, or to different labs over and over again until he finally gets a laboratory "result" he is happy with, even though the sample remains exactly the same. In this manner, if we were to resubmit the exact same samples collected and reported by NJH personnel to another lab, we would get entirely different results; and if we didn't like those data, we could just submit to another, and another, and another AIHA accredited laboratory until we did get "numbers" that we liked.

The Andersen samplers fare no better, and most laboratories misidentify the cultured organisms approximately 50% of the time, making any statements about specific genera unreliable.[107]

Conclusion Regarding Representativeness

None of the data presented in the NJH report exhibit representativeness. None of the samples collected by the NJH researchers represent the spore concentrations as claimed. The lack of representativeness fatally flaws this data and invalidates the NJH data.

Accuracy

The lack of precision associated with the reported NJH data would shift the emphasis for ensuring confidence toward *accuracy*. That is, in the absence of precision, one may rely

[105] 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

[106] The CDC Mold Work Group, National Center for Environmental Health, National Center for Infectious Diseases, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, October 2005

[107] Presented at the ASTM International Conference: *Bringing Science to Bear on Moisture and Mold in the Built Environment*, Colorado University, Boulder 2006

upon accuracy to interpret the data, provided there is sufficient confidence in the accuracy. "Accuracy" asks, "How close is the reported item or value (or both) to the actual value or item identified?"

If an Industrial Hygienist is performing an human exposure assessment of say, xylene in the air, and he collects a sample pursuant to NIOSH[108] air sampling protocols, [109] and sent the sample to 10 laboratories, the laboratories won't accidentally confuse, xylene with, say, methyl diisocyanate during the analysis, and report diisocyanate as xylenes, or vice versa. Rather 10 laboratories will all correctly identify the species of the analyte, and report xylene - that is, the method is accurate; the method can correctly identify the material. Similarly, each laboratory to whom the sample may be sent for analysis, will all report the correct identity of the compound and roughly the same concentration. The laboratories will be "accurate" and published QA/QC data will characterize that degree of accuracy.

However, such is not the case with the mold sampling and testing performed by NJH personnel at the selected marijuana grows. It has long been known (certainly since the mid 1940's) that not only is the precision associated with spore traps extremely poor, but the *accuracy* associated with the method is also extremely poor.

Throughout their report, the NJH authors erroneous state they enumerated "total" spore counts or "total viable counts" when in fact, they did no such thing. Neither the Andersen sampler nor the slit impactor used by the authors were designed to be capable of enumerating total spore traps, and neither is capable of representing total spores (or even total "viable" - as erroneously presented by the NJH authors). Contrary to that presented in the NJH report, each sampling method has only a limited inherent ability to enumerate specific types of spores at specific sizes. The sample devices used by the NJH researchers each have collection efficiencies that are very well established.[110]

The NJH authors never identified the type of spore trap employed. Nevertheless, all such impaction spore traps (as exemplified by the Air-O-Cell™ sampler and Andersen sampler) have a specific "cut-size" associated with the sampler. The "cut-size" is the aerodynamic diameter, in micrometers (µm), 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 the "total spore trap" used by NJH personnel (if it was one of the common commercially available slit-impactor spore traps) is reported as 2.3 µm. [111] This means that a mold spore whose diameter is approximately 2.3 µm has

[108] US National Institute of Occupational Safety and Health

[109] NIOSH Manual of Analytical Methods

[110] Macher J. Burge HA, *Sampling Biological Aerosols* Chp. 22 in *Air Sampling Instruments for Evaluation of Atmospheric Contaminants (ACGIH, 2001)*

[111] 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

only a 50% chance of being captured. Now, by comparison, the Andersen sampler used by NJH personnel has a d50 of only 0.65 µm[112] which means that the capture efficiency of this device is entirely different from that of the "total spore traps."

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 the reported NJH data), more recent information indicates the collection efficiency is much more complex. Also, as the airflow rate through the sampler increases, the cut-size decreases[113] and even more curious, the actual effective cut-size for the slit impactor can change as the mixture of spore sizes changes.[114] As the temperature changes so too changes the cut-size, (See Table 7, below) thus making an indoor (warm air temperature) comparison to an outdoor (cold winter day) comparison impossible without very complex corrections.

Flowrate (lpm)	Temperature F°				
	10	40	70	100	130
10	**2.7**	**2.8**	**2.8**	**2.9**	**2.9**
15	**2.2**	**2.2**	**2.3**	**2.3**	**2.4**
20	**1.9**	**1.9**	**2.0**	**2.0**	**2.1**
25	**1.7**	**1.7**	**1.8**	**1.8**	**1.8**
30	**1.5**	**1.6**	**1.6**	**1.6**	**1.7**

Table 7
Cut-size as a function of Temperature and Flow Rate[115]

Furthermore, as the sampling altitude increases, the cut-size also increases, therefore, performing the sampling in Denver (at 5,000 feet altitude) and trying to apply those data to New York, or San Francisco, or other sea level site, is further complicated.

[112] Lee KS, Black W, Brauer M, et al *A Field Comparison Of Methods For Enumerating Airborne Fungal Bioaerosols*, Presented at the Proceedings: Indoor Air 2002, Anaheim, California.

[113] 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

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

[115] Connell CP, *Field Measurements for Moulds: Spatial and Temporal Variations,* Presented at the ASTM International D22 Committee: Bringing Science to Bear on Moisture and Mold in the Built Environment, University of Colorado, June 2006

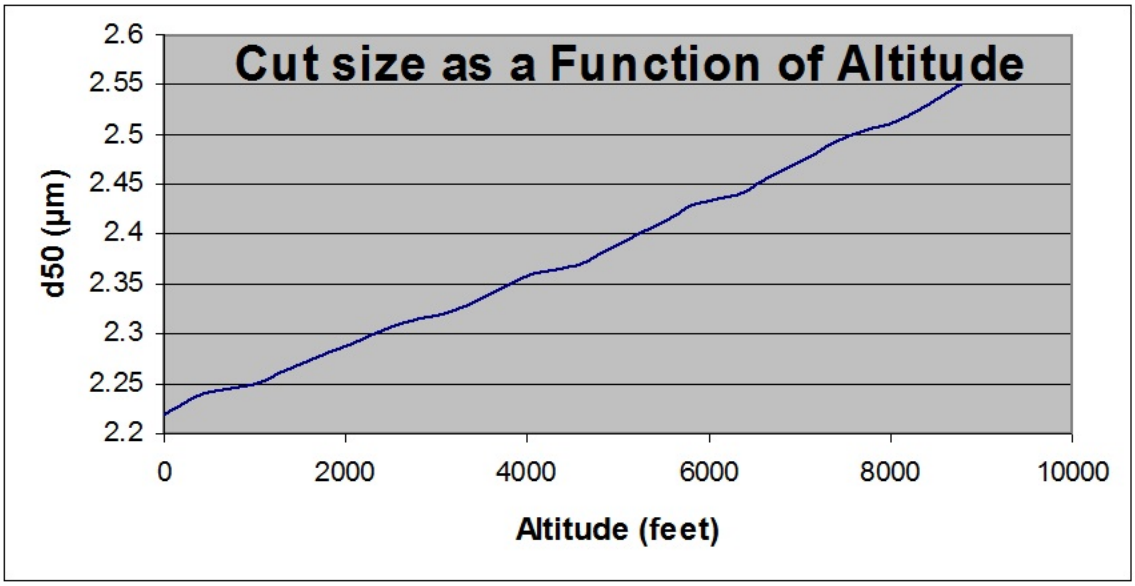

Figure 8
Cut-size as a Function of Altitude[116]

The net result is that even for just one sampler, 500 spores/m3 for Sample A could represent an atmosphere of 500 spores/m3 or it could represent 700 or 1,000 or 2,000 or 2,500 spores/m3 (or virtually any number in between) depending on what kind of spores are present. Since the NJH authors did not standardize their results to a specific spore size, the values reported are entirely and completely meaningless. A spore count of 1,000 spores/m3 outside is not the same as 1,000 spores/m3 inside, and a spore count of 200 spores/m2 outside could represent the exact same total count as 1,500 spores/m3 inside; only the temperature, and spore profile has changed, which results in a numerical change for the exact same total number of airborne spores in the atmosphere.

To complicate this issue, during the analysis phase, most labs misidentify the cultured organisms approximately 50% of the time, making any statements about specific genera unreliable.[117]

The above referenced Robertson study[118] demonstrated that not only are the samples themselves inherently variable and the precision is hopelessly poor, Robertson found something already known - the *accuracy* is also extremely poor. Robertson found that 25% of "proficient" AIHA accredited laboratories could not consistently identify *Cladosporium*, the single most common mold on the Planet Earth. Similarly, the NJH

[116] Connell CP, *Indoor Moulds: Recognition, Assessment, Significance, Anticipation and Control* (PCA Lecture Series; Huntington, England, Nov 2011)

[117] Connell CP, Presented at the ASTM International Conference: *Bringing Science to Bear on Moisture and Mold in the Built Environment*, Colorado University, Boulder 2006

[118] 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

report specifically identifies *Penicillium* spores as the preponderance of the extant genera in indoor air. The NJH author(s) state:

> We found that Penicillium species typically occurred within the MGO's at much higher concentrations than are present in the outside air.

And indeed, this statement would not be surprising since the *Aspergillus/Penicillium* spores are probably the second most common and ubiquitous spore types in the human environment; they are present in every home and building in the country. And yet, Robertson reported that these genera could not be correctly identified by half of the AIHA accredited laboratories that participated in his study. That is, only half the laboratories could consistently and confidently identify the second most prevalent mold known on the planet.

Therefore, not only could NJH personnel not confidently compare indoor to outdoor to determine if *Penicillium* actually was higher, and not only did NJH personnel not determine the actual spore concentrations in the marijuana grow operations, but the NJH researchers have offered no QA/QC data to demonstrate that they were actually capable of correctly identifying *Penicillium.*

The Robertson study concluded with information already known to legitimate Industrial Hygienists since at least 1976:

> *This research reveals that precision of spore trap analyses, even among laboratories involved with analytical proficiency testing, lack precision and should be interpreted with caution.*

Therefore, not only is there no confidence imparted to the numerical values reported in the data presented by NJH researchers, but there is similarly no confidence imparted in the reports of the various genera that the NJH researchers merely *believe* they have found.

Conclusion Regarding Accuracy

None of the data presented in the NJH document exhibit accuracy. The lack of accuracy fatally flaws the NJH data and invalidates the NJH data.

Comparability

The next parameter that must be addressed to determine if the data presented in the NJH "study" are valid is to ask, "Do the data speak to the question being asked?"

If, for example, a policeman wanted to know if a particular car was speeding, he wouldn't try to identify the manufacturer of the vehicle. The type of vehicle is not germane to the question being asked. Even if the car was a type of car known to be very fast, say a Maserati; that still would not answer the question at hand regardless of how accurately the identification was made.

If the policeman was to take a properly calibrated, accurate and precise police radar and announce the car is *accurately* travelling at *precisely* 53 mph, he would still be none the wiser - because the original question was not "How *fast* is the car going?" the original question was "Is the car *speeding*?" In order to know if the car is "speeding," the policeman must, of course, be confident in knowing with precision and accuracy the measured speed of the vehicle, and he must know that the measured speed is representative of the vehicle's actual speed. But now he must also address the missing component, for if the policeman doesn't know the posted speed limit for that section of road, then knowing the vehicle's velocity with accuracy, precision and representativeness is useless, since he has nothing against which to compare the vehicle's speed and answer the ultimate question, "Is the car *speeding*?"

The posted speed limit becomes the metric for comparison. While sitting on the highway in a 65 mph speed zone, prior to measuring a vehicle's speed, the police officer makes the *a priori* decision criteria that if a vehicle's speed is greater than 65 mph, then that vehicle is *speeding* and he will take specific, definable, actions. If the measured speed of a vehicle is less than 65 mph, he will decide that no action is required.

Indoor versus Outdoor Comparison Fallacy

In their report the, NJH author(s) have provided no metric against which to compare their data, or what valid criteria they will apply to define that which is “hazardous” and that which is “not hazardous.”

Instead, the NJH author(s) claim they are comparing indoor-to-outdoor samples; and if the indoor sample is five times higher than the outdoor sample, the concentration, is “hazardous” (regardless of the actual exposure).

Frequently, we poorly trained “certified mold inspectors” and other *de novo* “indoor mold consultants” performing an “indoor versus outdoor” comparison.[119] However, the practice is a logical fallacy of *argumentum ad populum,* and the justification for the practice becomes "…well, all the other poorly trained mold consultants are collecting outdoor samples for some reason, and so I too collect outdoor samples." This is not the basis of a rational, scientifically valid investigation.[120]

The outdoor air is not at issue, is not a criteria for determining if an indoor atmosphere is “hazardous,” is not part of the hypothesis testing and is not part of the question being asked. The collection of an outdoor sample for comparison in the manner seen in the

[119] As a result of new media hyperbole regarding mythical “toxic mold” a new industry has emerged wherein a person may merely declare themselves to be a “certified mold inspector” and offer their services as such. However, none of the “certificates” are recognized, and the practitioner virtually never has any legitimate knowledge in indoor molds.

[120] Oral testimony of Caoimhín P. Connell 220 W. Rittenhouse Square Condominium Association v. Myrna Stolker. Philadelphia CCP (Federal) April Term 2009 No. 02446 (Pennsylvania Federal Court), Honorable Gary F. Di Vito presiding (May 2012) – Frye challenge for Eckardt Johanning, M.D., M.Sc.; courts rejecting reports and counter challenges Dr. E Johanning and Dr. Chin Yang, PhD.

NJH report is otherwise almost exclusively seen amongst the junk-science, fear-based "toxic mold for gold" practitioners, and not amongst legitimate mold experts or legitimate Industrial Hygienists.

It has long been known that there is no correlation between indoor and outdoor spore concentrations in the circumstances under discussion. Investigators who practice indoor/outdoor comparisons are usually home inspectors, "toxic mold" remediation companies or other generalists, without the benefit of expertise in sampling, sampling theory, or aerobiology; and therefore, their erroneous statement has no utility in a legitimate human exposure assessment. It is well established that indoor to outdoor counts can be characterized based on both geographic location as well as altitude. At higher elevations[121] (and especially in the winter months) it is not uncommon to see indoor spore concentrations that are twice as high as outdoor levels in ordinary, clean, dry homes. [122]

The myth regarding indoor v. outdoor comparisons started with the publication of a hastily prepared document, falsely represented as a "standard" and used exclusively by "toxic mold" practitioners known as the "IESO Standard" which recommended comparing indoor to outdoor samples. (The "ISO Standard" is not a standard, and was never reviewed by any cognizant organization before release. Rather, it was a document prepared by a commercial laboratory that offer spore counting.)

The notion of comparing indoor spore counts to outdoor spore counts began with well respected researchers who alluded to indoor/outdoor generalities[123] and those generalities were then taken out of context and referenced inappropriately and have developed a life of their own outside the original scientific context.

For example, in the 1998 edition of NIOSH's Manual of Analytical Methods, QA/QC Chapter J, NIOSH[124] partially quoted a reference and stated:

> *In general, indoor microflora concentrations of a healthy work environment are lower than outdoor concentrations at the same location.(Macher & Burge 1995) If one or more genera are found indoors, in concentrations greater than outdoor concentrations, then the source of amplification must be found and remedied.*

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[121] Ebner MR, Haselwandter K, Frank A, I*ndoor and outdoor incidence of airborne fungal allergens at low- and high-altitude alpine environments* Mycological Research , vol. 96, no. 2, pp. 117-124, 1992 Referenced in Levetin E. Fungi (Chapter 5, Bioaerosols, Burge HA Editor, 1995)

[122] Ebner MR, Haselwandter K, Frank A, I*ndoor and outdoor incidence of airborne fungal allergens at low- and high-altitude alpine environments* Mycological Research , vol. 96, no. 2, pp. 117-124, 1992 Referenced in Levetin E. Fungi (Chapter 5, Bioaerosols, Burge HA Editor, 1995)

[123] Burge HA *Bioaerosols in the Residential Environment*, Chapter 21 in *Bioaerosols Handbook* (Cox CS, Wathes CM eds), 1995

[124] NIOSH is the US Department of Health and Human Services, Centers for Disease Control, National Institutes of Occupational Safety and Health.

NIOSH then references the source as: Macher JM, Chatigny MA, Burge HA [1995]. *Sampling airborne microorganisms and aeroallergens*. In: Cohen BS, Hering SV, eds. *Air sampling instruments for evaluation of atmospheric contaminants*, 8th ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 589-617.

However, if one goes to the original source (Macher & Burge, 1995), we see that the referenced authors made the first observation (the general comment about indoor v. outdoor concentrations), but did not make the *et sequitur* conclusion.

Placing the comments of the original cited authors back into context challenges the fundamental legitimacy of performing indoor/outdoor comparisons and is contrary to what the originating author wrote elsewhere. On indoor/outdoor concentration issues wherein the same original author (Burge) also in 1995, observed:[125]

> Indoor/outdoor relationships: *Unless there is an indoor source for specific bioaerosols, concentrations indoors will generally be lower than outdoors. This effect is related to the reasons for occupying enclosures, which are designed to protect us from adverse weather and intrusion by vermin or other unwelcome (sometimes human) visitors. The outdoor aerosol penetrates interiors at rates <u>that are dependent primarily on the nature of ventilation provided to the interior</u>. Indoor/outdoor ratios of specific particle types (of outdoor origin) are highest (tending toward unity) for buildings with "natural" ventilation where windows and doors are opened to allow entry of outdoor air along with the entrained aerosol As the interior space becomes more tightly sealed, the ratio becomes lower and lower.*

Therefore, the indoor/outdoor ratio of airborne molds is primarily a function of building systems and activity in the structure, and the indoor to outdoor ratio will rise and fall with the normal ventilation infiltration rate and other factors <u>not</u> related to indoor mold growth on marijuana plants or on the surfaces in the structure as an whole.

Unfortunately, poorly trained mold consultants have turned rationale into tautology and have repeated the unfounded practice so often (and out of context) it has taken on a life of its own and is misconstrued by the "toxic mold" practitioners as a normal practice. However, the oft repeated sentence still remains without scientific foundation.

Additionally, the spatial and temporal variations in spore concentrations for indoor samples, already described above, are equally seen in outside samples. The concentrations of outdoor spores vary enormously with species, location, altitude, season, climate and time of day; indeed, many organisms exhibit relatively predictable increases and decreases with time of day.[126] Samples collected from the outdoors will fluctuate wildly minute by minute.

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[125] Muilenburge ML, *The Outdoor Aerosol*, in Chapter 9 of *Bioaerosols*, (Burge HA, ed) 1995

[126] Madelin TM, Madelin MF *Biological Analysis of Fungi and Associated Molds*; Bioaerosols Handbook, Cox and Wathes, Eds. (1995)

Therefore, similar to indoor samples, unless one has collected a sufficient number of samples to properly characterize the outdoor population distribution and confidence intervals, one lacks the necessary precision to compare that sample with the indoor contemporaneous sample (let alone a single sample that was collected hours before, or hours after the single outdoor sample as was done by NJH researchers according to their "study").

That is - while the indoor spore concentrations are fluctuating wildly, the outdoor spore concentrations are doing the exact same thing, but in a different direction and at different times for different reasons, making indoor-outdoor comparisons a comparison of two moving targets; and therefore, completely meaningless. Imagine a mold consultant who concludes that an house with 500 spores/m3 inside is hazardous and the concentration indicates a problem, because the outside count was only 200 spores/m3; but the same consultant says that 500 spores/m3 inside is O.K. and doesn't indicate a problem, because the outside count was now 3,000 spores/m3. The question becomes an absolute - is 500 spores/m3 acceptable or unacceptable? And what difference does the outside count have on determining if the exposure inside is acceptable or unacceptable?

Imagine our example of a policeman running radar on the highway; he is measuring the speed of vehicles; however, he cannot see the posted speed limit sign and does not realize the speed limit is constantly changing; one moment the posted speed limit on the highway is 75 mph and the next moment it is 15 mph. Since the policeman can never be sure of the posted speed limit, he can never know whether a car is speeding or not speeding (even if he has accurately and precisely measured the car's speed).

It is for this reason that the samples presented in the NJH "study" claiming that the grow rooms had elevated mold spores since they were higher than the outside, is an invalid conclusion. In any event, as already established, the NJH author(s) never actually determined the spore loading in the grow operations and never determined the spore loading in the outdoors, and never determined the fungal profile of which spores were present.

Indeed, an ordinary, clean, dry home that has never had a mold problem or a water intrusion problem can very often have an average spore concentration greater than 1,000 spores/m3,[127] and can even have an average spore concentration that exceeds the outdoor air on any given day. The example below presents commonly seen spore trap results for moldy houses, clean houses and outdoor samples.[128] As can be seen, there is no correlation between indoor mold growth, indoor air concentrations and especially no comparison to be made with outdoor concentrations (even if the air testing is performed correctly).

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[127] Solomon WR. *Assessing fungus prevalence in domestic interiors*. J Allergy Clin Immunol. 1975 Sep; 56 (3):235–242. (Ref Levetin E. Fungi (Chapter 5, Bioaerosols, Burge HA Editor, 1995)

[128] Connell CP, *Sampling Strategies and Data Interpretation*, Environmental Information Association, Austin TX, 2010

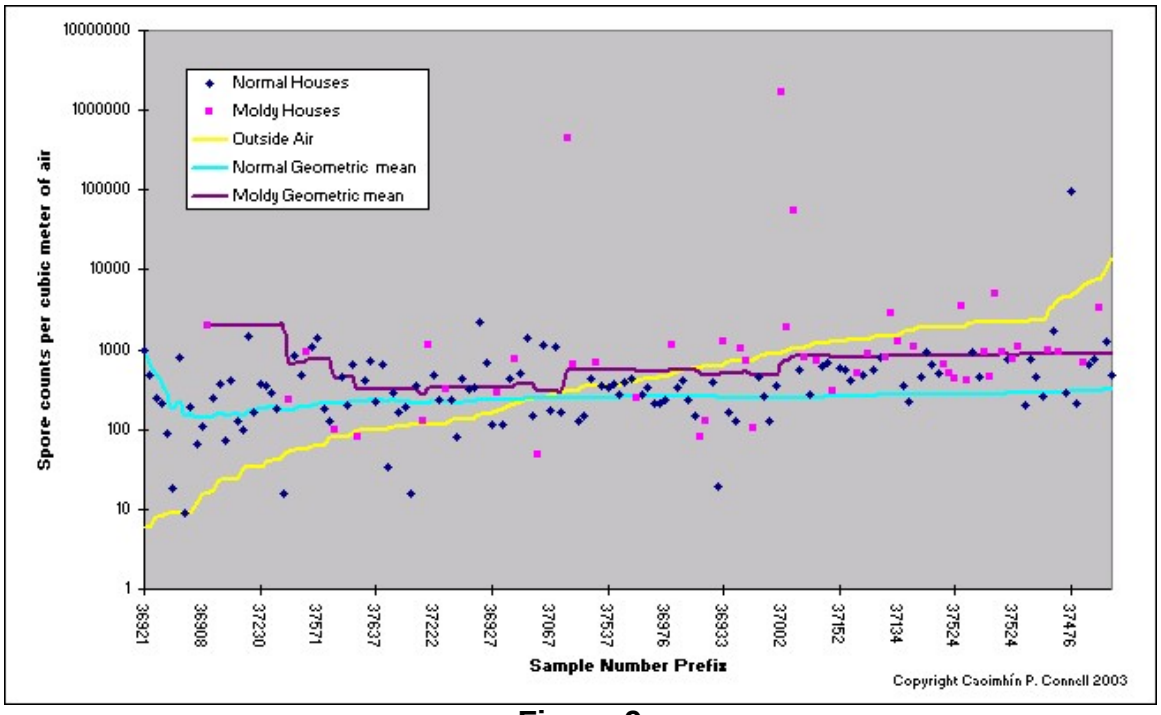

Figure 9
Comparison of Indoor and Outdoor Spore Traps

Regardless of the benchmark by which one may compare spore trap data, one thing is certain: Even if the air testing performed in the marijuana grow operations was valid none of the data confidently indicates that hazardous conditions were present at the grow operations or constitute any kind of health threat.

Conclusion Regarding Comparability

None of the data presented in the NJH report were presented with *a priori* decision criteria; or indeed, any decision criteria. The lack of decision criteria translatable to the question being asked, resulted in the poor quality of this data and invalidates this data.

CONCLUSIONS

The NJH report has unnecessarily alarmed first responders by announcing that hazardous molds, and hazardous mold concentrations occur in marijuana grow operations. The conclusions by the NJH are unsupportable and contrary to accepted science and are not support even by NJH's own data.

The quality of the NJH report is extremely poor, and is based almost exclusively on junk-science and appears to be an abandonment of known and established toxicological principles, science and sampling theory.

The conclusions by the authors are not supported by their data.

The authors ignored basic mathematical tenets and used mathematical manipulations that are inappropriate and contrary to good science.

The authors failed to employ scientifically valid sampling protocols in their assessments of indoor molds.

The authors rejected accepted toxicological paradigms and invented heretofore unknown, untested and unscientific toxicological metrics.

The concentrations of the molds reported in the marijuana grows were not valid.

The concentrations of the molds reported in the marijuana grows were not particularly elevated.

The concentrations of the molds reported in the marijuana grows were significantly lower than mold concentrations from other agricultural operations, which are generally regarded as safe.

The report contains many technical errors and false assumptions that are not supported by known science.

The report does not contain any information, or sampling data, indicating that molds present an otherwise unrecognized health hazard to first responders or to occupants of marijuana grow operations.

--END--