AN INDUSTRIAL HYGIENE CRITICAL REVIEW OF FUNGAL SAMPLING

At:

The Cascade Village Apartments Durango, Colorado

Prepared for:
Cascade Village Condominium Association
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EXECUTIVE SUMMARY

On April 29, 2008, Forensic Applications Consulting Technologies, Inc. (FACTs) received, from the Cascade Village Condominium Association (CVCA) in Durango, CO, copies of analytical results regarding mould concerns at Cascade Village (the subject property) generated by Ortiz Environmental Solutions, Inc. (OESI). At the request of the CVCA, FACTs has performed a standard industrial hygiene critical review of the reports and associated documents.

Based on our review of available documentation, sampling performed by OESI, although similar to that which has been seen from other poorly trained "mould inspectors",[1] and common within the "mould remediation industry" does not rise to a level of competency considered acceptable to the body of scientific knowledge, nor does it meet the current acceptable industrial hygiene standards for good sampling protocol.

- The sampling performed by OESI was not performed according to acceptable sampling theory, as described by the AIHA, ACGIH, National Institute of Occupational Safety and Health and other professional and technical organizations.

- The reports failed to follow accepted national consensus standards for reporting technical data.

- The sampling performed by OESI did not rise to the level of a "mould test" or exposure assessment.

- The sampling failed to characterize the extant mould present at the subject property and failed to provide a basis for developing a remediation strategy.

- The sampling and presentations by OESI appears to constitute junk science.

- The sample results provided by OESI are generally meaningless and uninterpretable.

- The OESI conclusions based on their sampling and analysis are generally foundationless, and cannot be supported by sound science or the sampling results.

- The recommendations proffered by OESI (such as fogging, and the application of fungicides) are unwarranted, unwise, and not supported by standard industry practices or good remediation practices.

[1] FACTs, Inc. is involved in microbial projects on an international scale. As such, throughout this discussion the international spelling "mould" is used, instead of the exclusively US spelling "mold."

- Although OESI referenced various public documents in their discussions and report, OESI either did not read their referenced documents, have not understood the contents of the referenced documents, or OESI ignored the contents of the referenced documents.

- The OESI report contains much that is contradictory and *argumentum ad populum* in the light of state-of-knowledge for the assessment of indoor fungi.

- The sampling and interpretation was apparently performed with disregard to accepted scientific principles and current knowledge and practices in aerobiology.

- The sampling and interpretation appears to be based on popular myth and common misconceptions usually associated with poorly trained consultants who usually refer to themselves as "Certified Mould Inspectors."

- The overall report, in our opinion, exhibits a gross lack of technical competency in issues surrounding indoor mould assessments, aerobiology and sampling issues.

- The sample results produced by OESI lack credibility and are largely useless.

- We found no indications in the documentation provided that unusual or excessive exposures to indoor moulds has occurred at the subject property.

- We found no indications in the documentation provided that would support a prohibition on entry by the general public into any of the areas tested at the subject property.

- Nothing within the document provided to FACTs suggests an unsafe environment vis-à-vis mould exposures at the subject property.

- Nothing within the document provided to FACTs suggest an "environment of concern" vis-à-vis mould exposures at the subject property.

The following discussion provides the rationale for our conclusions.

INTRODUCTION

In April of 2008, Forensic FACTs was contracted by the Cascade Village Condominium Association (CVCA) in Durango, CO to perform a state-of-the-art industrial hygiene review of selected reports prepared for the CVCA by a company referred to as Ortiz Environmental Solutions, Inc. (OESI), of Farmington, New Mexico.

Our assessment was restricted exclusively to reviewing the following material provided to us by the CVCA:

- OESI Mold Inspection and Sampling Report for the Cascade Village Apartments – Unit 322, April 11, 2008
- OESI Mold Inspection and Sampling Report for the Cascade Village Apartments – Unit 119, April 11, 2008
- OESI Mold Inspection and Sampling Report for the Cascade Village Apartments – Unit 315, April 11, 2008
- OESI Mold Inspection and Sampling Report for the Cascade Village Apartments – Unit 137, April 11, 2008
- OESI Mold Inspection and Sampling Report for the Cascade Village Apartments – Silverton Garage Cable Room, April 11, 2008
- OESI Mold Inspection and Sampling Report for the Cascade Village Apartments – Rental Shop, April 11, 2008
- OESI Mold Inspection and Sampling Report for the Cascade Village Apartments – Java Shop, April 11, 2008
- OESI Mold Inspection and Sampling Report for the Cascade Village Apartments – Reception Office Building Shop, April 25, 2008
- OESI Mold Inspection and Sampling Report for the Cascade Village Apartments – Benchmark Apartment, April 11, 2008
- OESI Mold Inspection and Sampling Report for the Cascade Village Apartments, April 11, 2008 (this document appears to be a synopsis of each of the individual "assessments").
- Mold Intro and Glossary – No date, no author (appears to be from OESI)

FACTs Assessment Personnel

The critical review was performed by Mr. Caoimhín P. Connell, Forensic Industrial Hygienist with FACTs, Inc. With the exception of the insurance carrier, American Family Insurance, neither Mr. Connell, nor FACTs, has any other association with any of the parties involved. American Family Insurance is a current client of FACTS in a project involving the theft of a van in Denver, CO which is contaminated with methamphetamine. The aforementioned project with American Family Insurance is independent of, and creates no conflict of interest with, the CVCA project under discussion.

FACTs is an wholly woman-owned business, incorporated in the State of Colorado providing objective scientific Industrial Hygiene consultation to private commerce, government, and individuals.

Mr. Connell possesses specialized knowledge in several areas of industrial hygiene including indoor microbiology, microbial assessments, development of sampling protocols (including the development of sampling and analysis data quality objectives), chemical exposures, analytical chemistry, and indoor air quality (IAQ).

Mr. Connell has been a practicing Industrial Hygienist (IH) since 1987 as defined in Colorado Revised Statutes Title 24 §30-1402. Prior to entering the IH field, he had approximately ten years experience in analytical and research laboratories in the United States and abroad as a chemist, research technician and laboratory technician.

Mr. Connell has been performing microbial assessments and critical reviews for approximately 20 years. He has specifically performed microbial assessments and investigations for over 19 years. Mr. Connell has performed microbial investigations in a number of litigious cases and for such highly acclaimed organizations as the Mesa Laboratory of The National Center for Atmospheric Research, where he currently serves as the contract Industrial Hygienist. He has performed similar work in numerous cases in the capacity of an expert witness[2, 3, et al]

Regarding the type of work associated with the CVCA project, Mr. Connell's clients have included the U.S. Geological Survey (USGS), Health and Human Services (HHS), Federal Bureau of Prisons, and the National Institute of Standards and Technology (NIST). He currently serves on three International ASTM Standards Committees:

- Committee D22.08 on Indoor Air Quality
- Committee E30 on Forensic Sciences
- Committee E50 on Environmental Assessment, Risk Management and Corrective Action

On the ASTM D22.08 committee, Mr. Connell serves as a technical reviewer and coauthor developing and writing protocols for the assessment of fungi in buildings and indoor air. Mr. Connell is a member of the American Industrial Hygiene Association and the Occupational Hygiene Society of Ireland and a frequent speaker on indoor microbial issues for professional organizations, and has lectured on risk assessment and toxicology at the university level.[4]

[2] Kalka V. US (Civil Action No. 91-Z-753), 1995

[3] Dr. Robert Powers vs. Embassy House Condominium, *et al* 03 CV 1766, 2004

[4] Lecturer at Denver University, as part of the Masters Degree in Science Program, through the late Professor Rupert C. Burtan, M.D., M.P.H., D.P.H.

Mr. Connell is a recognized authority in the development of sampling and analysis Data Quality Objectives (DQOs), and was the primary author of the Data Quality Objectives for the State of Colorado Department of Public Health Regulations 6 CCR 1014-3, 2005.[5]

The investigations upon which the following opinions were formed were based on work which involved standard industry practices, accepted and standard procedures and accepted and standard methodologies. No new methodologies were introduced or used in this work. Similarly, no new or untested scientific methodologies were used, and no new applications for otherwise accepted methodologies were introduced or employed. The data generated during this investigation was interpreted to the highest standard of care.

Scope of Work

Based on information provided to us by CVCA, heavy snows in late 2007 and early 2008 resulted in water and moisture intrusion at specific locations in buildings associated with the CVCA. Following reported episodes of water and moisture intrusion, remediation activities were initiated.

At some point in time after the initiation of the remediation activities, consultations regarding indoor moulds were sought by the management company.

The management company hired OESI to perform unspecified mould testing at the subject property. OESI generated several document associated with their work. FACTs was hired by the CVCA to evaluate the reports generated by OESI.

FUNGAL ASSESSMENT PROTOCOL

Traditionally, issues regarding human exposures to potentially hazardous entities have been in the realm of the Industrial Hygienist – a profession defined in Colorado by state statutes. Industrial Hygienists usually have a background in science, and, typically toxicology, microbiology, epidemiology, sampling theory and chemistry are part of that background. Mould assessments in buildings are squarely within the realm of expertise of the practicing Industrial Hygienist. [6,7]

Mould Inspectors

Recent media coverage of indoor moulds has placed the mould issue into the realm of science fiction. As a result, a plethora of self-certified "mould experts" and "certified

[5] State of Colorado, State Board Of Health Department Of Public Health And Environment, *Regulations Pertaining to the Cleanup of Methamphetamine Laboratories*, 6 CCR 1014-3, (Appendix A and Attachment to Appendix A) Adopted January 19, 2005, effective March 30, 2005: www.forensic-applications.com/meth/coloregs.html

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

[7] 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

mould inspectors" have entered the newly recognized market providing wildly inaccurate and entirely unscientific consultations regarding mould, its occurrence, assessment, significance of human exposures, and remediation protocols.

Although the OESI reports identify the author of the reports, Mr. Donald P. Ortiz, as a "Certified Residential Mold Inspector", there are no valid or recognized certifications for "Mould Inspectors" (or other such terms as commonly used) in the State of Colorado since there is no governing body which accredits the certifications. Essentially, anyone with a computer may merely declare themselves a "certified mould inspector" and then print out their own "certificate" to "prove" their qualifications. Some individuals may receive no training prior to declaring themselves "certified mould inspectors" and most of the "certified" classes known to FACTs are taught by instructors who themselves have no training in microbiology and who often exhibit anti-scientific views of moulds in light of the more lucrative "toxic mould" agenda. Most of the classes are taught by laboratories that performs sample analysis, and place an almost exclusive emphasis on collecting samples (thus increasing its own analysis revenues).

To demonstrate the validity of the "certified" mould inspector qualification, included with this Critical Review, as Appendix A, is a certificate, wherein FACTs has bestowed upon Mr. Robert Oppenheimer, President of the CVCA the title "Certified Mould Inspector." Mr. Robert Oppenheimer may now, with equal legitimacy as that of Mr. Donald P. Ortiz, refer to himself as a "Certified Mould Inspector" in Colorado and may thereby perform indoor mould inspections under that title. To our knowledge, Mr. Oppenheimer has no training whatsoever in mycology, microbiology or building assessments, however, this limitation does not interfere with the legitimacy of the certification.

The current popular myth of "toxic mould experts" notwithstanding, it is our position that sound and established industrial hygiene science, toxicology, and microbiology should form the basis of mould assessments and human exposure assessments including human exposure assessments to moulds.

It is important to understand that even the term "toxic mould" is a recent creation of the news media – there is no such thing as "toxic mould" *per se*, and similarly, there is no significance imparted to "black moulds." Not only are these descriptors created by recent news media, but scientifically there is not even a clear classification for "mould" since <u>any</u> fungus exhibiting filamentous (hairy) extensions is called a "mould." Therefore, an organism may be a "mould" at certain points in its life cycle, and not a mould at others. Indeed, it is possible for a single organism to be a mould, a yeast, and "just a fungus," at different times in its life depending on its morphological state.

Accepted Assessment Protocols for Indoor Moulds

Visual Assessment For Indoor Moulds

Currently, according to standard industrial hygiene practices, an assessment of moulds in indoor environments is performed almost **exclusively** on the basis of a visual inspection[8] by a properly trained individual, usually an Industrial Hygienist, construction engineer, or a microbiologist/mycologist.

In their documentation, OESI reference the work prepared by the New York City Department of Health[9] as a reflection of state-of-the-art in microbial investigations and remediation.[10] However, the work performed by OESI was contrary to those very guidelines which addresses the air sampling conducted by OESI thusly:

> *Air sampling for fungi should **not** be part of a routine assessment. This is because decisions about appropriate remediation strategies can usually be made on the basis of a visual inspection.*

OESI also referenced the US Environmental Protection Agency, however, the EPA publication, "*Mold Remediation in Schools and Commercial Buildings*"[11] states:

> *A visual inspection is the most important initial step in identifying a possible contamination problem.*

We do not see anywhere within the information provided to us that OESI performed or adequately reported on an acceptable visual inspection of the subject property. Rather, it would appear that OESI exclusively relied upon invalid sampling to form their opinions and recommendations.

Sampling

As a general rule, inappropriate sampling, such as that performed by OESI, at the Cascade Village Apartments is almost exclusively performed by "certified mould inspectors," mould remediators and other poorly trained "mould consultants" who are otherwise unfamiliar with mould. This "sampling" and its associated laboratory report is used as a way to provide perceived instant credibility to their services by "puffing up" a report with fancy Latin names and numbers on a laboratory report, but providing little

[8] Robbins C, Morrell J; *Mold, Housing and Wood* (Article prepared for the Western Wood Products Association), Jan 2006.

[9] Bureau of Environmental & Occupational Disease Epidemiology publication titled *Guidelines on Assessment and Remediation of Fungi in Indoor Environment* (April, 2000).

[10] Although a new version of the New York City Guidelines is available, the earlier version is considered by most cognizant authorities as that which more closely reflects the industrial hygiene community's adherence to sound scientific principles.

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

real data. Many mould inspectors rely on the "CSI effect"[12] wherein there is a misplaced belief by the American consumer that a laboratory report somehow magically represents unchallenged scientific truth. In fact, laboratory reports have no intrinsic value outside of the context of the expertise of the sample collector and the sample collector's *a priori* data quality objectives (DQOs). Most "mould inspectors" seem to be oblivious to decades of established sampling theory and sampling protocols, in lieu of popular, but invalid, practices; OESI appears to either be unaware of valid sampling principles, or they have ignored valid sampling principles.

In either event, the US Department of Health and Human Services, Centers for Disease Control (CDC) recognizes the frivolity of such sampling in mould assessments when it stated:[13]

> *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 "Chapter 2: Assessing Exposure to Mold" of the above referenced document, the CDC 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)

Although OESI also referenced the EPA, the EPA recommends against the kind of sampling performed by OESI except in unusual circumstances and then only by a legitimate scientist, specifically including an Industrial Hygienist, and only when the Industrial Hygienist has established proper sampling data quality objectives. [14]

The EPA states:

> *Is sampling for mold needed? In most cases, if visible mold growth is present, sampling is unnecessary.*

The EPA warns:

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

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[12] Connell C.P. *Forensics by Any Other Name*, The Monitor, Newsletter of the ASSE, Volume 6, No. 2, 2006

[13] 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

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

The reports prepared by OESI indicate that the authors are entirely unfamiliar with designing mould sampling protocols, sampling methods, and interpretation of results.

The EPA states:

> *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.*

We address legitimate sampling protocols later in this discussion. However, in addition to the EPA document referencing both the AIHA, (which this reviewer, Connell, is a member) and the ACGIH, OESI also explicitly references both organizations. However, the ACGIH, also states that the primary emphasis on indoor mould assessments should rest with a thorough visual inspection of the property.[15]

The EPA document continues with:

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

Nowhere within the provided documentation did we see that OESI had any kind of a sampling plan, and no sampling plan was referenced in the OESI material.

The EPA states:

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

Based on the lack of technical competency exhibited in the OESI report, we conclude that OESI lacks legitimate experience in performing this kind of work.

Finally, the US EPA states:

> *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!*

Nowhere in the OESI report have we found any evidence that OESI used any kind of sampling plan, or tested any kind of a "theory." It would appear that invalid samples were collected without any articulable reason and without any end in mind.

It is difficult to understand how OESI could reference the above documents, and recognize that the documents contain legitimate state of the art information, but then ignore the content of those same documents.

[15] 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.

International ASTM Standards currently under development for the assessment of indoor moulds in buildings, specifically **excludes** all sampling during mould inspections; thus reflecting current thought. This author (Connell) is a technical reviewer on the ASTM International D22 Committee. In the last few days, Mr. Connell concluded a final review of the pending international guidelines which will be titled: *GUIDE FOR THE ASSESSMENT OF FUNGAL GROWTH IN BUILDINGS*. In that guide, which reflects state-of-the-art and standard industry practices, and is being developed by an international committee of recognized indoor mould experts, air sampling (even properly conducted air sampling) and bulk sampling is discouraged and is considered by the cognizant community as superfluous and misleading.[16]

Data Quality Objectives

As already mentioned, in their documentation, OESI referenced the AIHA and the ACGIH, and referenced the EPA which too alludes to these two professional organizations. Therefore, we can stipulate that all parties involved recognize the special skills the legitimate industrial hygienist brings to the equation.

A foundational industrial hygiene tenet used by both of the referenced organizations, is the establishment of data quality objectives (DQOs). The DQOs are the "theory" and "sampling plan" mentioned by the EPA.

Prior to the collection of virtually any kind of sample, whether it is an air sample or tape sample or bulk sample, the sample collector needs to establish *a priori* data quality objectives. The establishment of DQOs is the quality assurance, quality control (QA/QC) part of a larger hypothesis testing or decision making process; the results of sampling and analysis will either support or not support the hypothesis but only in the context of the DQOs.

The DQOs ensure, through their prescription, that tenable and statistically valid results ensue. The DQOs ensure that a statistically sufficient number of samples will be collected from statistically representative locations in an acceptable manner by a validated method or method whose uncertainties are sufficiently characterized. The DQOs further specify that the samples are submitted to a laboratory capable of proficiently analyzing the samples to within a definable uncertainty, using valid methods (not all "mould" labs do this). The parameters of the DQOs themselves are based on statistical confidence needed to answer the *a priori* questions. DQOs are what make laboratory results meaningful (and tenable in the event of litigation). Without DQOs, one does **not** have data on a laboratory report; one has mere numbers and names on the laboratory report that cannot be interpreted by anyone, since the "numbers" have no intrinsic meaning outside of the context of the *a priori* decision criteria.

[16] Connell C.P. *Mold Rush: A Commentary*, EH&S Solutions, Nov/Dec 2003

We did not find anywhere in their reports where OESI considered any kind of DQO, neither did OESI interpret the data to any QA/QC parameters nor did they collect the samples pursuant to any DQOs. According to the US Centers for Disease Control:[17]

> *If you do decide to pay for environmental sampling for molds, before the work starts, you should ask the consultants who will do the work to establish criteria for interpreting the test results. They should tell you **in advance** what they will do or what recommendations they will make based on the sampling results.*

The DQO process is so entrenched in good environmental sampling that it is the underpinning of all such sampling and is discussed in great detail in many broad-spectrum environmental sampling protocol and Industrial Hygiene sampling protocols. It is for this reason, that the EPA references the AIHA and the ACGIH. For example, one of the "bibles" of general environmental sampling is the US EPA SW846[18] geared toward environmental sampling. The sampling precepts and the QA/QC 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.*

Parameters of Airborne Spore Sampling Interpretation

The interpretation and reporting criteria of air sampling is commonly framed within the context of "PARCC" parameters (precision, accuracy, representativeness, comparability, completeness).

Since OESI entirely failed to provide any data quality objectives, their data is uninterpretable. Here, we have used standard PARCC parameters to evaluate the OESI airborne spore trap results.

[17] US Centers for Disease Control, *Mold: General Information: Basic Facts | CDC APRHB*, 2007, http://www.cdc.gov/mold/faqs.htm

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

Precision:

Precision asks: *How reproducible are measurements; has the variance been characterized?*

This is important, since it directly speaks to the issue of how well a single sample would represent an area.

Axiom 1: All samples exhibit uncertainty.
Axiom 2: All analysis results exhibit uncertainty.

These statement are true regardless of the parameter being sampled. The precision of the data collected by OESI is entirely unknown because OESI entirely failed to develop and/or follow a sampling plan that would determine the precision of the samples. It is an established and industry accepted fact that particle migration (such as spores) is mainly influenced by particle properties, ventilation conditions and airflow patterns.[19] Particle concentrations in general,[20] and spore concentrations in particular,[21] within a structure exhibit large spatial variations[22] which tend to be compartmentalized within a given space.

Furthermore, it is a well established and a standard sampling precept that short term samples (such as those used by OESI) exhibit very large temporal variations.[23] Generally, the geometric standard deviation of interday and intraday airborne concentrations lie between 1.2 and 2.5 geometric standard deviations.[24] These large variations are similar to those seen by other authors, specific to airborne mould concentrations[25, 26, 27] some of whom have reported even higher fungal variations in indoor air.[28]

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

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

[21] 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

[22] 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.

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

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

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

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,[29] and states that random grab samples are the least desirable technique for estimating the average exposure.[30] It was, in fact, grab samples that were exclusively collected and reported by OESI using exclusively single random grab sample methods[31] whose normal total sampling time was less than 1% of the anticipated exposure time.[32] This error is known as the "sampling design error," and if uncharacterized (as in the OESI data) produces huge uncertainties in the reported results. (Although a counsel of perfection, "Shannon's Sampling Theorem"[33] estimates that the number of measurements needed to achieve "perfect information" about airborne concentrations is roughly 250,000 measurements per cubic meter per hour.)

More practical foundational and accepted classic industrial hygiene references[34, 35] have estimated that for each daily study period (expressed as any 8 hour period), between eight and eleven random grab samples are needed for any single study area to obtain adequate confidence in the average airborne concentration estimate. Some authors[36] state that as

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

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

[28] Reponen T, Nevalainen A, Jantunen M, *et al, Normal 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).

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

[30] Ibid.

[31] Although the M2 cassette used by OESI is a duel slit sampling cassette, each drawn sample constitutes a single sample.

[32] Although OESI failed to identify sampling times, they reported collecting 150 liters of air. If they were using the cassettes as designed, the air volume would indicate a 10 minute sample.

[33] As referenced in Rock JC; *Occupational Air Sampling Strategies*, Chapter 2 of *Air Sampling Instruments for Evaluation of Atmospheric Contaminants (ACGIH, 2001)*

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

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

[36] 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.

many samples as necessary to determine the distribution should be taken. As such, one, two or even three or four samples collected in a manner, such as those collected and reported by OESI at the Cascade Village cannot provide adequate confidence in estimating the spore concentration at the subject property. Based on the information we reviewed, OESI typically collected a single sample from each sampling area.

As an example of normal expected variations, the following data are real data and are very typical from a Colorado home. The samples below were collected using a method virtually identical to the OESI samples (except the samples were collected based on established DQOs).

Time of Sample	Spore Concentration s/m3
08:00	213
09:30	1195
11:00	393
12:30	567
14:00	900
15:30	3257

Table 1
Typical Distribution of Spores In a Colorado Home[37]

In viewing this table we see immediately that the data results vary wildly over the course of the day, and one may ask:

"Which sample represents the spore concentration for the home?"

Answer:

"They all do. They are all correct, and none of them are contradictory."

Several times in their report,, OESI states "A normal clean area is within 200-400 spores per m3." Although this statement is not necessarily correct, using that as the basis for OESI's interpretation, if OESI personnel had collected the sample at 08:00 in the above referenced model residence, they would very likely have concluded this home did not have a mould problem; whereas if they collected the sample at 15:30, they would have had the opposite conclusion, even though BOTH samples are correct, and the conditions in the residence have not changed. These kinds of variations are normal, **expected** variations, and almost certainly the same variations that would be seen in each of the indoor and outdoor environments at the Cascade Village. However, OESI has entirely failed to recognize this physical parameter and established aspect of air sampling, and

[37] In the above closed-mode building data set, the one-tail percentage point of the W test =0.7880; the Shapiro-Wilk W test (goodness of fit) is 0.9890, indicating lognormal distribution (Gaussian distribution is rejected since W for normal is 0.7800). There is 95% confidence any single randomly collected sample will exceed 1,000 spores/m3 65% of the time; the MVUE for the above data set is 1,058 spores/m3 with a GSD of 2.6 This data set was taken from a residence that did not have any mould related complaints.

they have reported single values without context or confidence intervals. Samples collected pursuant to proper DQOs define the variance and determines the validity of any one, or a set, of sample data; [38] OESI failed to fulfill this element of good sampling protocol.

OESI does not appear to even attempt to reconcile the large variations in their own samples seen in the Cascade Village Reception Office Building. For example, the relative percent difference (RPD) between the highest and second highest sample from occupied spaces in the Reception Office Building was a whopping 180%. Yet nowhere in the OESI report do they attempt to explain why they blindly accepted such huge differences in their own samples, in light of their interpretation guidelines of 200 to 400 spores per cubic meter for normal spaces, or what the differences mean, or why the differences occurred, or how much larger could the differences have been? Instead, OESI merely ignores the outlier.

Non-Symptomatic Buildings

As mentioned above, in their report, OESI states, "A normal clean area is within 200-400 spores per m3." OESI provides no reference for this range, neither does OESI explain how this range is derived or for whom or how it applies. The referenced value appears to have been merely fabricated without substance.

Based on our in-house database of total fungal counts (spores and fragments), as determined by a spore trap that is virtually the same as that used by OESI, the fungal counts for indoor samples[39] in buildings <u>not</u> experiencing fungal problems usually have an MVUE[40] of less than about 500 spores per cubic meter (spores/m^3).[41] However, due to normal variations, even in those properties, the indoor concentrations exceed 900 spores/m^3 12% of the time. This means that even in perfectly clean, dry, normal houses, **<u>during closed-mode conditions</u>**, one out of every 10 samples will exceed 1,000 spores per cubic meter of air and a finite probability that any one sample will exceed any given elevated value. Clean, dry, normal houses under "open-mode" conditions may have average spore concentrations exceeding 20,000 spores per cubic meter of air.

Symptomatic Buildings

By comparison, based on our database, total fungal counts in buildings with fungal problems, the MVUE is greater than 40,000 spores/m^3 and fungal concentrations exceed

[38] Generally speaking, and certainly at FACTs, because of the expected variations, we express the "average" value as the MVUE.

[39] Closed mode conditions.

[40] The statistic known as a "minimum variance unbiased estimate" (MVUE). The MVUE is considered to be a statistic that best represents a point estimate of the true "mean" for lognormally distributed values. The MVUE is preferred over the geometric mean, especially when sample sizes are small.

[41] Although FACTs discourages sampling, over the course of the last several years, we have collected approximately 850 air samples for fungi following carefully designed DQOs in a variety of environments.

900 spores/m^3 66% of the time.[42] The *viable* fungi concentrations for symptomatic environments is 3,190 CFU/m^3, with a 60% probability that any one randomly collected sample will exceed 900 CFU/m^3.[43]

Essentially, this means that in even the "cleanest" house with no mould problem, there is a finite and high probability that a single sample (or two or three) will exceed even, say, 3,000 spores per cubic meter of air; and that in even the mouldiest of houses, a single sample may be as low as 3,000 spores per cubic meter of air. Therefore, since the precision of the reported OESI data cannot be known, their indoor samples cannot be interpreted as being either "high," "normal" or "low."

A *prima facia* interpretation of the data reported by OESI necessarily leads one to a conclusion that the incomplete and unreliable samples collected by OESI indicate unusually *low* spore concentrations, if anything at all.

Summary of Precision

The air samples collected by OESI are entirely unusable since there is no confidence in the data based on precision. The collection method of the samples exhibit a gross lack of technical competency in aerobiological sampling methods, and sampling methods in general.

Based on the data presented by OESI, **none** of their data indicate elevated airborne moulds as claimed. In the sections below, we will explain why even the samples collected from areas such as the Java Shop and Unit 137, etc. do NOT indicate unusually elevated spore counts.

Accuracy:

Accuracy asks: *How close is the reported value to the true value?*

The lack of precision associated with the reported OESI data would shift the emphasis for ensuring confidence toward *accuracy*. That is, in the absence of precision, one may rely upon accuracy to interpret the data, provided there was sufficient confidence in the accuracy. Each sampling method has only a limited inherent ability to enumerate specific types of spores. The types of samplers used by OESI (slit impactors) is very common, and it's collection efficiency is very well established.[44]

[42] n=136. Data exceeding the upper quantifiable limit (estimated to be 1.7E6 spores/m3) were censored to 1.7E6 spores/m3.

[43] n=13

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

The sampler has 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."

Generally, at the recommended flow rate of 15 liters per minute (recommended by the manufacturer) at normal temperature and pressure, the d50 for the sampler used by OESI is *reported* as 2.5 µm.[45] This means that a mould spore whose diameter is approximately 2.5 µm has only a 50% chance of being captured. Most of the fungal conidia reported by OESI are at or near this aerodynamic diameter; therefore, immediately, the accuracy of the results must have error bars wherein the confidence of the result lies within one half to twice the reported values.

Having said this, the OESI samples were not collected under standard conditions, since the altitude of Durango shifts the d50. 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 OESI data), more recent information indicates the collection efficiency is much more complex and as sampling altitude increases, and/or the sampling temperature increases, the cut-size also increases; as the airflow rate through the sampler increases, the cut-size decreases[46] and even more curious, the actual effective cut-size for the slit impactor can change as the mixture of spore sizes changes.[47] We do not see where OESI has considered these issues in their interpretation of their data. In fact, as already mentioned, we find that OESI entirely failed to provide any information on the flow rates used, or how they determined the or confirmed flow rates of the sampling equipment.

So, we know that a profile of spores was being selectively lost during OESI's sampling, but OESI has not told us what that profile looks like or what it means.

The up-shot is that not only is the *precision* of the data generated and reported by OESI extremely poor, the *accuracy* of the data is also extremely poor due to the inherent limitations of the samplers used in the absence of DQOs. OESI does not appear to understand that the accuracy of their data is very limited.

[45] Alegro Industries, Operator's Manual, IS013 Rev E 7-7-05 (Allegro Industries, 7221 Orangewood Avenue, Garden Grove, CA 92841)

[46] 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

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

Relevancy:

Relevancy asks: *Do the data speak to the* a priori *question being asked?*

As already noted, contrary to EPA and CDC recommendations, OESI does not appear to have established *a priori* conditions or hypotheses; therefore, how could the samples speak to relevancy? As stated by the US EPA, a consultant performing sampling such as that performed by OESI, should have *a priori* data quality objectives that explain why the samples thus collected are relevant to the issue at hand.

Disregarding good sampling protocols,[48] OESI does not seem to have actually asked an *a priori* question, developed an hypothesis to test, or provided any point of relevancy to the collection of the samples. Furthermore, OESI performed wall cavity sampling in some locations, and occupied space sampling in other locations without any explanation of why the sampling criteria should have changed.

Furthermore, OESI did not explain why spore counts in a wall cavity were relevant to the issue at hand (indeed, OESI never actually defined the issue at hand). Therefore, presuming the issue at hand was human exposures to mould spores, OESI never explained how a disturbed wall cavity sample could be related to an indoor human exposure.

Regarding exposure issues; typically, we look at an "exposure triangle" consisting of , 1) a source, 2) a susceptible recipient (the human), and 3) a migration pathway between the source and the recipient. Where one of these elements is missing, the remaining two, regardless of degree, are inconsequential. Therefore, where a potential insult exists, such as an indoor mould, it's mere presence does not necessarily equal exposure, and exposure does not necessarily equal illness. Where exposure exists, it does not necessarily mean that a sufficient dose has been received to result in a physiological effect.

When OESI collected wall cavity samples, they appeared to be making the case that the concentrations were relevant, but OESI never explained why or how the concentrations may be relevant, or identified or characterized the migration pathway from the source to the recipient.

OESI appears to follow an unfounded misconception among poorly trained consultants and mould remediators that mould in wall cavities presents a significant exposure threat. However, the source and human recipient notwithstanding, there is no significant migration route between the wall cavity and the human; and therefore, no significant exposure; and therefore, no significant dose received.

By contrast, when the front door of a residence in Durango, Colorado, is opened on a nice Spring, Summer or Autumn day, approximately two cubic meters of air are displaced and introduced into the residence. At a normal outdoor concentration of, say, 10,000 spores

[48] Burge HA, *Bioaerosol Investigations*, Chapter 1 in *Bioaerosols* Burge HA (ed), 1995

per cubic meter, the occupant has just introduced 20,000 mould spores into their home in a matter of seconds; just by opening a door and walking into their home. How would that value compare to the spore concentrations possibly migrating from the interior wall cavity?

FACTs personnel have performed many fugitive emissions and migration studies[49] and have found that for particulates, such as mould, the air movement through a wall cavity capable of carrying mould spores or other fungal entities is so small as to be entirely insignificant by comparison.

Since the route of migration is insignificant, this element too breaks the necessary chain and the source, however large or small, becomes unimportant since there is no reasonable way for the source to get to the recipient.

In any event, in general, it is recognized by the cognizant scientific community that colonization of mould inside wall cavities does **not** present an exposure issue:[50]

> *…it is reasonable to infer that small amounts of mold enclosed in walls, floors, or ceilings will not have a large impact on the indoor air quality.*

The Wisconsin Department of Health and Family Services investigated the relationship between mould on surfaces of oriented strand board siding and mould levels inside the home; the results of the study indicated mould levels in the affected homes were not significantly higher than those measured in non-exposed homes.[51]

As such, to our knowledge, there is no compelling reason to sample for mould spores inside wall cavities; or to address such sources if suspected of merely being present. This is consistent with the opinion of one of the world's leading experts on mould, Dr. Harriett Burge who stated:[52]

> *However, removal based on the mere fact of its presence, or based on nonspecific symptoms that are not related to mold exposure, is often not appropriate.*

---

[49] See for example, Rasmuson J, Hall D, Birkner L, Connell C, Martyny J *A computational fluid dynamics (CFD) and tracer gas comparison of the spatial distribution of an airborne contaminant in an office space as a function of general ventilation* (American Industrial Hygiene Association, American Conference of Governmental Industrial Hygienists AIHce, June , 2007, Philadelphia, PA)

[50] Robbins C, Morrell J; *Mold, Housing and Wood* (Article prepared for the Western Wood Products Association), Jan 2006.

[51] Daggett DA, Chamberlain M, Smith W. *Effects of Exterior Decay and Mold on Indoor Mold and Air Quality*. Proceedings of the 2nd Annual Conference on Durability and Disaster Mitigation: November 6, 2000; Madison, WI

[52] Burge, H. *Can Mold Be Safely Left Inside Walls?* The Environmental Reporter, Vol. 3, No. 11, November 2005

Studies and investigations performed by this author (Connell), consistent with other researchers, have not observed a correlation between mould hidden in walls and a degradation of indoor air quality or a correlation between mould hidden in walls and an increase in spore counts in occupied spaces.

Finally, OESI did not explain how the wall cavity samples were collected. Typically, these samples are collected in a "disturbed" state. Generally, the wall cavity is sectioned or cored to gain access to the cavity (this activity "disturbs" the normal spore loading in wall cavities and immediately increases the spore concentrations), and then the consultant "thumps" on the wall three times to agitate the spores in the cavity and dislodge the spores rendering those spores airborne.

Therefore, the wall cavity samples thus collected by OESI are **not** relevant to indoor exposures, and the results cannot be translated to a metric germane to human exposures.

Similarly, the sampling performed in the loft of the Reception Office of the Cascade Village is also a "disturbed" sample. Generally speaking, air movement in a structure is from the occupied space into the attic or loft. OESI has not explained why they believe the loft concentrations are germane.

OESI has entirely failed to explain why it performed the sampling or what the sampling means, or how the sampling results are meaningful.

Indeed, based on the conclusions provided by OESI, none of the samples or sample results provided any information that was not already known prior to sampling, but did provide misleading conclusions that were not otherwise supported.

Comparability **(Points of reference):**

OESI alludes that it used two points of reference:

1) 200 to 400 spores per cubic meter of air
2) A single outdoor sample accompanied by the cryptic statement:

> *You can use the outside background sample which resulted in 101 spores per m3.*

OESI does not explain how "you" can use the outside sample, or why OESI believes the single datum of 101 spores per m3, taken from a lognormally distributed data set represents the "background." We presume that OESI has presented the two points as references to be used to compare the remainder of their data.

Although it is common practice among poorly trained "mould inspectors" and especially among mould remediators to compare indoor airborne levels with outdoor levels, this kind of comparison is generally considered *argumentum ad populum* in the light of state-of-knowledge. It has long been known that there is no correlation between indoor and outdoor spore concentrations in the circumstances under discussion, and investigators who practice indoor/outdoor comparisons are usually poorly trained generalists without

the benefit of expertise in indoor aerobiology; and therefore, the comparison has little use in a legitimate assessment.

It is possible that the myth regarding indoor v. outdoor comparisons started with notable, well respected researchers (as also referenced in the OESI report) who alluded to indoor/outdoor generalities[53] and those generalities were then taken out of context and referenced inappropriately.

For example, in the 1998 edition of NIOSH's Manual of Analytical Methods, QA/QC Chapter J, NIOSH[54] 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.*

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. (OESI also referenced Macher, 1999)

However, if one goes to the original source (Macher & Burge, 1995), we see that the authors made the general comment about indoor v. outdoor concentrations, but did **not** make the *et sequitur* conclusion – rather that was an unsupported editorial misinterpretation by NIOSH.

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 author wrote elsewhere on indoor/outdoor concentration issues wherein the same original author (Burge) also in 1995, observed:[55]

> *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 that are dependent primarily on the nature of ventilation provided to the interior. 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.*

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

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

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

Therefore, the indoor/outdoor ratio of airborne moulds is primarily a function of building systems, and the indoor to outdoor ratio will rise and fall with the normal ventilation infiltration rate and other factors not related to indoor mould growth.

Unfortunately, over the course of time, poorly trained "mould inspectors" and mould remediators have repeated the NIOSH quote out of context so often that it is now misconstrued to a point of perverse "normality" exclusively through tautology, but the oft repeated notion still remains without foundation.

Additionally, the spatial and temporal variations in spore concentrations already described for indoor spore counts are equally large outside (but for slightly different reasons). The concentrations of outdoor spores vary enormously with species, location, altitude, season, climate and time of day, and indeed, many organisms exhibit relatively predictable increases and decreases with time of day.[56]

Therefore, similar to indoor samples, unless one has collected a sufficient number of samples to properly characterize the outdoor population distribution, one lacks the necessary precision to compare that sample with the indoor contemporaneous sample (let alone a sample that was collected hours (or days) before, or hours (or days) after the single outdoor sample, as was apparently done by OESI).

That is - while the indoor spore concentrations are fluctuating wildly, the outdoor spore concentrations are doing the exact same thing, but at different times. When legitimate sampling protocols, such as those found in official NIOSH reference documents, make allusions to the comparisons of indoor to outdoor concentrations,[57] they axiomatically are indicating that one has actually measured, with confidence, the actual concentration used in the comparison, and not simply taken one or two or three unreliable samples (such as with the OESI data). The OESI grab samples merely represents a "snap-shot" and not the overall concentration. For example, where NIOSH recommends comparing indoor to outdoor samples, they also state:[58]

> *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.*

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

[57] Chapter J - Sampling and Characterization of Bioaerosols; NIOSH Manual of Analytical Methods (NMAM®), 4th ed. DHHS (NIOSH) Publication 94-113 (August, 1994), 1st Supplement Publication 96-135, 2nd Supplement Publication 98-119, 3rd Supplement 2003-154

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

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, the consultant performing an indoor to outdoor comparison would have collected six samples for fungi, six samples for mesophilic Bacteria, six samples for thermophilic actinomycetes from each study area, and six samples of the same parameters from an indoor control area and six samples from the outside. This is a far cry from the OESI sampling protocol of collecting one or two meaningless samples from the indoor areas and comparing that with one meaningless sample from the outdoors.

In the EPA document referenced even by OESI, the EPA states:[59]

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

In the table below, we have presented very typical instantaneous indoor/outdoor collocates taken pursuant to legitimate DQOs from a normal Colorado home.

Time	Inside Spore Count (s/m3)	Simultaneous Outside Spore Count (s/m3)
10:00	971	6
13:15	16	112
15:23	33	102
18:06	426	133

Table 2
Indoor versus Outdoor Spore Counts[60]

As can be seen from the above data, the indoor counts are showing the expected large variation (lognormal distribution), and simultaneously, the outdoor samples are similarly showing their expected large variation (lognormal distribution). However, the polarity of the sample ratios changes.

In its discussion, OESI references an organization called the IESO.[61] In our experience, the IESO is used almost exclusively by poorly trained "instant" mould experts who

[59] Mold Remediation in Schools and Commercial Buildings U.S. Environmental Protection Agency (EPA 402-K-01-001, March 2001 updated June 25, 2001)

[60] 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

frequently refer to the IESO documents as "standards." However, the IESO is **not** a recognized standards authority, and does not establish national consensus standards, as claimed. These "standards" used by OESI are not considered to be scientifically valid, and do not carry any weight in legitimate discussion amongst *bone fide* indoor environmental quality experts.

Essentially, the IESO "standards" were developed a couple of years ago by a particular laboratory in an effort to promote sales. The IESO "standards" were rolled out in a matter of weeks, and the "standards" (such as IESO 2210) are mostly myth-based procedures devoid of any actual scientific merit, and lacking any credibility.

The "standards" make a central point of using outdoor airborne mould levels as comparison to indoor levels. However, as explained above, this is an example of *argumentum ad populum* in the light of state-of-knowledge; essentially IESO makes the case that "since everyone else seems to be doing it, it must be correct." However, it has long been known, that there is no correlation whatsoever between indoor and outdoor spore concentrations in the circumstances under discussion, and investigators who practice indoor/outdoor comparisons are usually "certified mould investigators," and mould remediators who lack any particular scientific training, who lack a knowledge of sampling theory and who lack any knowledge in aerobiology.

By comparison, *bone fide* national consensus standards organizations would include ASHRAE[62], ANSI[63] and ASTM International.[64] These organizations publish technically exhaustive *standards* that are consensus criteria developed by hundreds of professionals across the globe over the course of many years and can carry both weight of law and state-of-the-art and state-of-knowledge credibility.

The promulgation of true standards is an arduous process involving literally hundreds of experts. For example, the ASTM International Indoor Air Quality Committee has been engaged in the promulgation of an indoor mould assessment *standard* for over four years. The process involves the vetting of the language and the science by a broad spectrum of scientists, medical personnel, engineers, public policy experts, and others before the *standard* will see the light of day. Ultimately, an entire ASTM standard could be held up on the opposition of just one expert, until consensus is achieved or the objection is shown to be unsupported by sound science. By contrast, the IESO was formed in 2002, and the "standard" was instantly published without review by any organization or expert anywhere.

Even the IESO indicates it's lack of technical merit in its own standards. IESO 2210, explicitly states, in its own language, that the standard is **not** technically exhaustive, and

[61] Indoor Environmental Standards Organization

[62] American Society of Heating, Refrigeration and Air-conditioning Engineers

[63] American National Standards Institute

[64] Formerly the American Society for Testing and Materials

should only be used to determine if an appropriate *specialist* (e.g. an Industrial Hygienist) is required for further investigation. Indeed, the IESO 2210 clearly states:

> 7.0 Applicability and Limitations
>
> 7.3 The results and recommendations made by the inspector relative to this standard are not a warranty, surety, or guarantee of any nature or kind.

By this statement, the IESO is explicitly and honestly telling the world that the standard carries no weight.

OESI in its report, by referencing the IESO and the value of 101 spores per m3 for the outdoor sample and stating that "***You can use the outside background sample which resulted in 101 spores per m3***" argues that if the indoor count is higher than the outdoor count, there is a "mould problem" within the home. However, in truth, comparing one-on-one samples is a meaningless pursuit; and, as demonstrated in the typical example above, if one used that decision criteria, this particular home would have "elevated" spore counts (and thus a mould problem) at 10:00 a.m. and 6:00 p.m, but would be considered normal by OESI's standards at 1:15 p.m. and half past three in the afternoon.

In a similar example, the table below presents another actual data set from a normal residential mountain setting in Colorado. The data were collected as part of an unpublished study by FACTs using legitimate DQOs, and an identical sampling spore trap technique as used by OESI.

Time	Data Set A	Data Set B	Data Set C
08:45	419	1,306	2,629
10:20	290	4,484	3,000
12:12	452	2,306	3,000
14:15	484	14,065	3,468
16:16	742	7,339	3,048
16:45	210	5,290	3,242
MVUE	434	5,858	3,064

Table 3
Indoor versus Outdoor Spore Counts

In this case, a "Certified Residential Mold Inspector" had frightened an elderly couple with meaningless "mould tests." The "consultant" managed to frighten the couple into leaving their home. FACTs performed scientifically valid sampling in the "contaminated" home, in the outdoors and in another home in the area (not experiencing any mould related problems) as a control. The windows and doors in the study home were closed and the occupants maintained closed-building conditions. The occupants of the control home kept the all the windows in the building open during summer months. The MVUE listed in the table is the actual "average" based on the lognormal distribution.

Do the data in the above table intrinsically identify which home had a mould problem, which home was the healthy control home or which data set represents the outdoor

samples? They do not: In the above table, Data Set A was collected from the "contaminated" home; Data Set C was collected from the healthy control area; and Data Set B were samples collected from the outdoors.

Regarding indoor versus outdoor comparisons, too many broad statements are made by poorly trained consultants, such as OESI, without due consideration for building conditions and regional and microclimate changes which can greatly alter the variations in concentrations and can greatly alter the relationship between the indoor environment and the outdoor environment.

Furthermore, in Colorado, our seasonal changes are so large, that on some days, we may open our doors and windows permitting not just direct communications between indoor and outdoor spore concentrations, but actual equilibrium of the outdoors spore concentrations with the indoor air spore concentrations. [65]

Without knowing the weather in Durango, CO on April 7th, 2008 and April 17th, 2008 when OESI collected their samples, and without knowing the conditions of each study area wherein OESI collected their samples (that is the degree of passive ventilation and infiltration rates between indoor and outdoor and indoor activities at hand), no one, not FACTs, not OESI, and not any expert in the world can know the meaning of the indoor data reported by OESI. Therefore, the sample data are meaningless and cannot be used for comparison.

Extensive FACTs data indicate that for samples collected under "closed building conditions," regardless of the region, there is poor correlation[66] between indoor and outdoor fungal profiles (genera, species and total counts) whether the building is a "problem" (symptomatic) building or a "healthy" (non-symptomatic) building. Studies by other researchers[67] have made similar conclusions regarding outdoor versus indoor influences, particularly with regard to particulates.[68]

In the graphic below, we have presented data for indoor and outdoor fungal concentrations for both symptomatic (problem) buildings and non-symptomatic (healthy) buildings collected in Colorado. [69]

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

[66] Least squares fit, $r^2 = 0.058$

[67] Cooley J.D.; Wong W.C.; Straus D.C.; Jumper C.A. *Correlation between the prevalence of certain fungi and sick building syndrome*, Occupational and Environmental Medicine, September 1998, vol. 55, no. 9, pp. 579-584(6)

[68] El-Hougeiri N., El-Fadel M.IAQ *Characterization In Urban Areas: Indoor To Outdoor Correlation* Proceedings: Indoor Air 2002

[69] 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

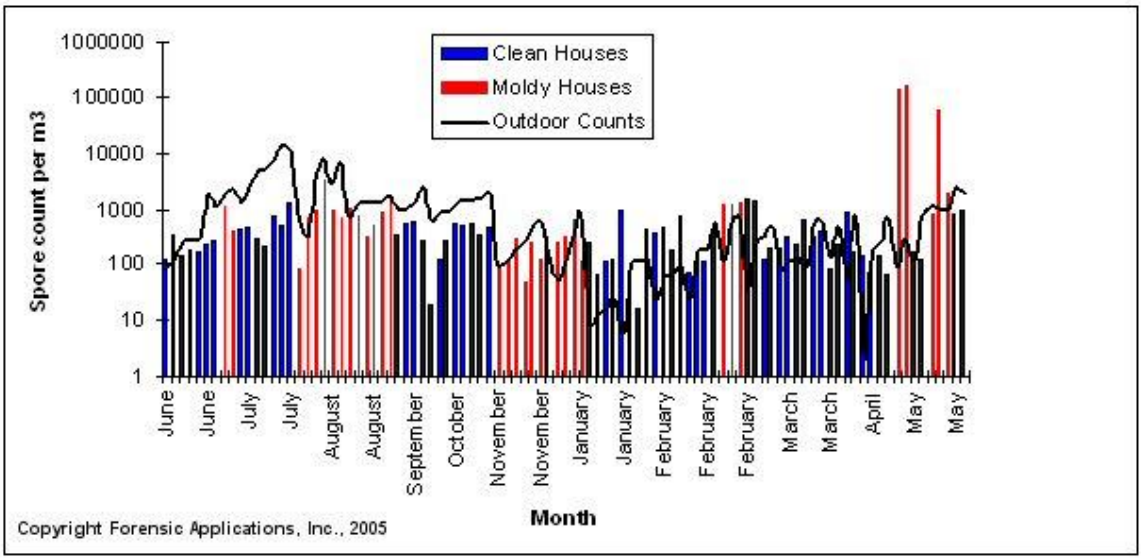

Figure 1
Indoor to Outdoor Spore Concentrations
Comparisons for Colorado Homes

As can be seen from the above graph, there are clearly times when "problem" homes have spore concentrations less than outdoor concentrations and when healthy homes have spore concentrations higher than outdoors. Some studies purporting to demonstrate correlations between indoor and outdoor air[70], however, exhibit fatal flaws upon closer scrutiny, and those studies do not survive scientific rigor.[71]

Furthermore, it is a well accepted fact that outdoor spore concentrations change dramatically with seasons, and exhibit a bi-modal distribution which peaks in the early spring and early autumn. And, although our definition of season (summer, autumn, etc.) is based upon the equinoxes, moulds, being living organisms, are more interested in mean diurnal temperatures, precipitation levels, sun light cycles, relative humidity and so forth, for their living and growth conditions.

In the data set graphic below, for Colorado, winter outdoor MVUE fungal counts are about 209 spores/m3, with individual counts exceeding 900 spores/m3 approximately 10% of the time. Spring counts are approximately 900 spores/m3 with individual counts exceeding 900 spores/m3 approximately 40% of the time. The summer counts average about 3,500 spores/m3 with individual counts exceeding 900 spores /m3 approximately 72% of the time. And yet, non-symptomatic indoor counts remain roughly the same throughout the year (horizontal central line).

[70] Shelton BG, Kirkland KH, Flanders WD, Morris GK, *Profiles of American Fungi in Buildings and Outdoor Environments in the United States* Applied and Env. Microbiology April 2000 pp 1743-1753

[71] Connell CP, *Indoor Fungal Concentrations* http://www.forensic-applications.com/moulds/mvue.html

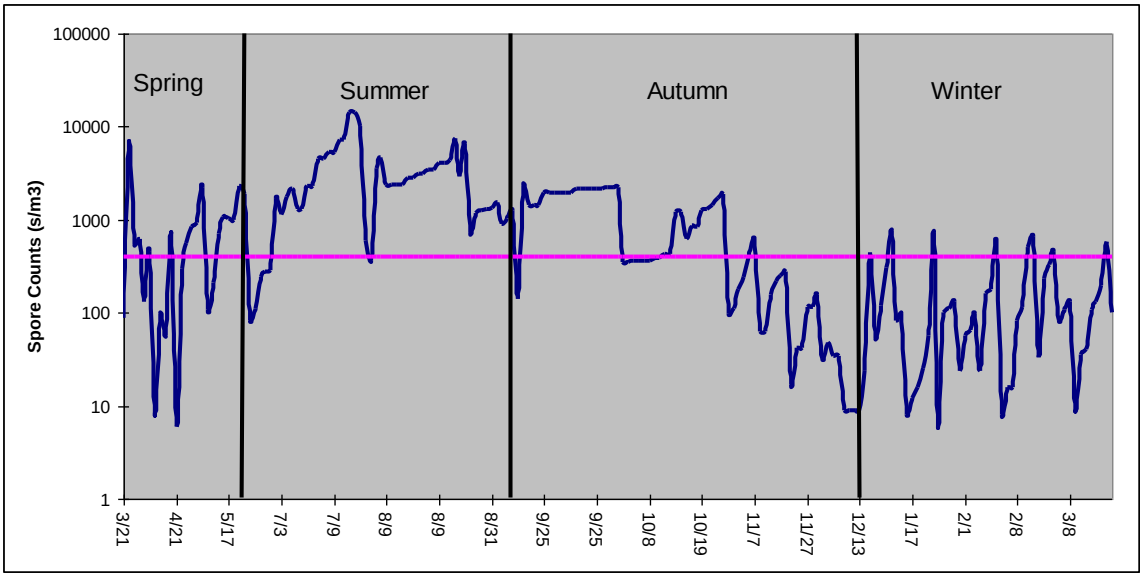

Figure 2
Outdoor Spore Counts Vary With Seasons

Therefore, in Colorado, the representative indoor spore count in normal, healthy houses will exceed the outdoor counts almost four months of the year. Consultants who claim that a problem exists if the indoor counts exceed outdoor counts ignore the fact that the spore counts in healthy houses stay relatively stable, but the outdoor seasonal counts fluctuate around the indoor concentrations. Therefore, according to the criteria found in the OESI report (by referencing the IESO documents), healthy houses contain excessive levels of moulds in the winter but are normal in the summer, even though the spore counts in the houses have not changed.

Summary of Comparability

We believe that in making unfounded comparisons, OESI has erroneously represented their data when they state on several reports that they have identified elevated and extremely elevated spore counts. Nowhere in the OESI data sets or reports presented to FACTs have we seen **any** indication that OESI identified or documented elevated spore counts, and nowhere has OESI demonstrated that the samples identified as "elevated" or "extremely elevated" are translatable to human exposures.

The OESI statements in their reports are so fraught with mischaracterizations, unsupported conclusions, and abjectly incorrect assertions, that it is difficult to address.

We note that some of the sampling data have been provided to an individual identified as Dr. Donald Cooke, described to us as "a local board certified Allergy-Immunology Specialist." Therefore, it may be salient to look at actual referenced values, for spores, by the American Academy of Allergy and Immunology (AAAI):[72]

[72] American Academy of Allergy and Immunology http://www.aaaai.org/nab/index.cfm?p=reading_charts

Total Spore Count (spores/m^3)	Classification	Allergy sufferers who are allergic to these pollens or moulds may experience symptoms of hay fever
0	Absent	No symptoms.
1 - 6499	Low	Only individuals extremely sensitive to these pollens and moulds will experience symptoms.
6500 - 12999	Moderate	Many individuals sensitive to these pollens and moulds will experience symptoms.
13000 - 49999	High	Most individuals with any sensitivity to these pollens and moulds will experience symptoms.
>50000	Very High	Almost all individuals with any sensitivity at all to these pollens and moulds will experience symptoms. Extremely sensitive people could have severe symptoms.

Symptom and Spore Count Guidelines of the American Academy of Allergy and Immunology

Other researchers have reported "allergic thresholds" for specific moulds such as 3,000 CFU/m^3 for the ubiquitous genus *Cladosporium*.[73]

Completeness:

Have all the DQOs been met; i.e. are the data reliable and do they exhibit *confidence*?

Since no DQOs were ever established by OESI, no DQOs could have been met. The samples do not exhibit reliability and do not exhibit confidence.

Swab Samples

Generally speaking, swab samples provide less useful information regarding moulds during an assessment than do air samples. In our experience, based on what is now known about indoor mould assessments, swab samples are generally used by otherwise technically incompetent consultants to increase the cost of their services, and provide perceived credibility by having a genuine lab report, (the actual value of the samples notwithstanding). In this case, the referenced laboratory apparently used by OESI for at least one data set was a legitimate and well respected lab. However, the laboratory does not determine the value of the samples collected- the laboratory merely analyzes any submitted sample regardless of the validity of the sample.

[73] Gravensen, S. *Fungi as a cause of allergic disease* Allergy (34): 135-154, 1979; as reported in Ren P; Jankun TM; Leaderer BP; *Comparisons of seasonal fungal prevalence in indoor and outdoor air and in house dusts of dwellings in one Northeast American county* Journal of Exposure Analysis and Environmental Epidemiology (9) 560-568; 1999

During its assessment, OESI collected swab samples. However, the purpose of the swab samples, and their utility is never explained in the OESI report. OESI states that the purpose of the swab was to identify the genus of the mould present in a specific area. However, OESI never explains why knowing the genus is of any particular importance, and indeed their "recommendations" appear to be exactly the same, regardless of the genera identified.

Generally speaking, a legitimate consultant with specialized knowledge in indoor moulds can adequately identify the genus of a particular colony just by looking at it; and the same legitimate consultant also knows that the actual genus is entirely inconsequential to remediation plans since the decision making process for remediation is not altered by knowing the genus, or species or the actual spore count on the swab.

Indeed, OESI does not seem to have actually used the results of the swab samples except to erroneously state that the result was "extremely high." In fact, there is no foundation provided by OESI to indicate that the spore count was anything but normal and expected. After all, what would OESI have expected to find when one samples a mould colony? A result of 3 million spores in an area the size of one square centimeter as reported is not uncommon.

Possible Sampling Rationale

In its reports, OESI provides possible rationale for otherwise unfounded sampling. In its April 25, 2008 report, OESI makes a cryptic statement:

This count (sic) also contains other spores not found in the other air samples with stachybotrys (sic) being of major concern.

OESI does not explain why they explicitly proffer the belief that *Stachybotrys* is "of major concern." In fact, *Stachybotrys* is quite simply not remarkable. Every structure in Colorado contains *Stachybotrys*. Daily, it is likely that every human within our latitude is exposed to this ubiquitous mould. In our experience, the presence of *Stachybotrys* is the "cash cow" frequently used by "get rich quick" consultants and remediators who implicate, without scientific validity, this genus as the prototypal "indoor toxic mould." However, early studies suggesting that this mould was responsible for specific health problems have long since been discredited by the US Centers for Disease Control and withdrawn, and the presence of *Stachybotrys* is no more interesting or of health concern than any other indoor mould; indeed, possibly less so, since *Stachybotrys atra* does not appear to be quite as allergenic as other indoor moulds.

To our knowledge, the scientific and medical literature does not contain a single valid, confirmed, case of stachybotrytoxicosis as a result of exposures to this organism in normal living conditions even where the organism has exhibited confluent growth.

Media reports and "certified mould inspector's" allusions to *Stachybotrys* as a "toxic mould" usually center on the, now discredited, reports of mould related illnesses. The

media has frequently used early reports of mould related illnesses cited by the U.S. Department of Health and Human Services, Centers for Disease Control (CDC) and has failed to follow up with more recent reports which refute the initial reports found in CDC publications.

In general, contrary to public belief, indoor moulds are rarely responsible for adverse health effects over and above that seen from common outdoor exposures. Indeed, generally speaking, indoor exposures to moulds are frequently lower than outdoor exposures, **even in houses with visible mould contamination.**

Returning to the EPA document cited by OESI, the EPA states:

> *There are only a limited number of documented cases of health problems from indoor exposure to fungi.*

The guidelines continue with:

> *The presence of fungi on building materials as identified by a visual assessment or by bulk/surface sampling results does not necessitate that people will be exposed or exhibit health effects. In order for humans to be exposed indoors, fungal spores, fragments, or metabolites must be released into the air and inhaled, physically contacted (dermal exposure), or ingested.*

However, even *Stachybotrys atra*, which is probably the most maligned and feared indoor mould, is not as "toxic" as the media portray. The trichothecene mycotoxin which has given *Stachybotrys* a bad name is produced by only about a third of the species of *Stachybotrys*.[74]

Furthermore, the mycotoxins are not always produced by the organisms that do occasionally produce the compound; the mycotoxin is only produced under very specific stress conditions. Furthermore, the mycotoxin, when it is produced, is only produced in the spores and the spores are not readily removed from the main organism. It takes an unusual amount of mechanical effort to make the spores become airborne. The spores, when they are shaken loose, are so large they settle out within about 10 minutes[75] and so do not remain airborne for very long. Thus for a significant dose to occur, the recipient must be located in the immediate vicinity where the organism is being heavily disturbed. Finally, since there is only approximately 3 femtograms of toxin per spore,[76] it would take over 300,000 spores in a rodent's lungs to produce the one nanogram of toxin conservatively estimated as the quantity of toxin needed to make the animal ill. Based on

[74] Personal conversation between Caoimhín P. Connell and Bruce Jarvis, PhD, Professor of Chemistry and Biochemistry University of Maryland at College Park, October 27, 2000.

[75] Personal Lecture notes of Caoimhín P. Connell (Lecture by Dr. H Burge, Harvard School of Public Health, Boston, Mass. May 2000).

[76] 1999 Personal communication between Caoimhín P. Connell and Dr. Bruce Jarvis, (referencing Sorenson, W.G.; Frazer D.G; Jarvis, B, Simpson J, and Robinson, V. 1987. *Trichothecene mycotoxins in aerosolized conidia of* Stachybotrys atra. Applied Environmental Microbiology 53:1370-1375.

these considerations, a human would have to be exposed for 100 continuous eight-hour days at 1,000 *Stachybotrys atra* spores per cubic meter to get the required amount of toxin.[77]

It is for this reason, that Dr. Vincent Miller, a researcher in the field of indoor moulds, stated:[78]

> *Based on this model, it becomes apparent that most exposures to mold contaminated buildings would not be expected to cause adverse health effects.*

These thoughts were echoed by Dr. Burge, who wrote:[79]

> *These types of exposure are extremely rare and occur primarily in agricultural situations. Even for cancer, consistent exposure to levels higher than in the vast majority of homes and office/school workplaces would be necessary. These effects have only marginally been documented in agricultural situations. In general then, one can reassure patients that the symptoms they are experiencing, although real, are probably not associated with mycotoxin exposure. With the mycotoxin issue set aside, one can then proceed to a more likely diagnosis.*

This opinion was also echoed by the American College of Occupational and Environmental Medicine who, in November 2002, issued a peer reviewed Evidence Based Statement,[80] wherein they made the observation that:

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

News media hype notwithstanding, in general, the academic, scientific, and medical communities do not support the current high profile concerns regarding indoor moulds in general and certainly not *Stachybotrys* in particular.

Dr. Abba Terr M.D. summed up the medical field's opinion in a peer-reviewed journal when he wrote:

> *No convincing cases of human allergic disease or infection from this mould* [Stachybotrys] *have been published*. [He concluded] *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.*

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[77] Miller R.V; Martinez-Miller, C; Bolin, V *A Risk Assessment Model for Mycotoxin-Producing Molds On Human Health In Indoor Environments.* AeroTech Monitor, Vol. 3 No. 1, 2000

[78] *Ibid.*

[79] Burge, H.A, *Fungi: toxic killers or unavoidable nuisances? Annals of Allergy Asthma Immunology 2001; 87(Supp l):52-56*

[80] 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.

Members of the CDC also performed a review of the available medical literature regarding moulds and mycotoxin exposures in the indoor environment, and in the peer reviewed journal for the American Industrial Hygiene Association, the authors concluded: [81]

> *This review of the literature indicates that there is inadequate evidence to support the conclusion that exposure to mycotoxins in the indoor (nonindustrial) environment is causally related to symptoms or illness among building occupants.*

In a similar literature review by Frederick Fung with the Sharp Rees-Stealy Medical Group and University of California San Diego, Dr. Fung reported in the Journal of Clinical Toxicology[82] that:

> *A critical review of papers, reports, and studies on* Stachybotrys *mycotoxins revealed only descriptive reports of suspected animal and human poisoning secondary to consumption of mould contaminated foods. No studies of good toxicologic and epidemiologic designs answer whether airborne mycotoxins produced by* Stachybotrys *could produce specific human toxicity.*

Dr. Burge also performed a review [40] of available literature and her assertion was: The review yielded many studies of the role of fungi in allergic disease, but none that systematically documented such a role for mycotoxins or fungal volatiles. Many case studies were found, but none of these unequivocally document a cause/effect relationship between mycotoxin exposure by inhalation and human disease in residential, school, or office settings. Dr. Burge concluded:

> *The review led to the conclusion that that the primary result from fungal exposure is allergic disease, and that the evidence for inhalation disease resulting from mycotoxin exposure in residential and office settings is extremely weak.*

Finally, perhaps one of the most thorough and comprehensive reviews of contemporary literature on the subject (replete with 465 references) was the Kuhn and Ghannoum review[83] which concluded that

> *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.*

If sampling was performed by OESI due to concerns for mycotoxins, then why didn't OESI assess mycotoxins in the air? Similarly, we don't know why OESI singled out

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[81] Page, EH; Trout, D.B, *The Role of* Stachybotrys *Mycotoxins in Building-Related Illness* Journal of the American Industrial Hygiene Association, September, 2001

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

[83] 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

Stachybotrys atra since hundreds of common indoor moulds also produce mycotoxins, some of which are much more powerful mycotoxins than produced by *Stachybotrys atra*.

For example, one of the single most potent natural carcinogens known to man are the aflatoxins. Aflatoxins are mycotoxins that are produced by several common indoor moulds, including moulds found at the subject property. Aflatoxins are produced by various members of the genus *Aspergillus*. Toxicologically, aflatoxins are more significant than the approximately 40 mycotoxins that are occasionally produced by *Stachybotrys.* Why then, is OESI concerned about an obscure mycotoxin producer, but doesn't even mention the more significant mycotoxin produced by members of *Aspergillus*? Similarly, if the trichothecene mycotoxin specifically was, for some unexplained reason, the primary concern of OESI, then why did OESI not address the other common moulds that also produce similar trichothecene mycotoxins such as *Trichoderma* which produces sequiterpenes, very similar to the trichothecenes.

Similarly, moulds belonging to the genus *Penicillium* produce probably the single most studied mycotoxin of all – penicillin (as well as several other mycotoxins such as the mycotoxin responsible for rubratoxicosis). To argue that residential exposures to mycotoxins produced by residential moulds result in physiological effects, is a tacit argument that one could cure a "strep throat" by exposure to the penicillin that occurs when one occupies an house containing the mould *Penicillium chrysogenum*.

In truth, the presence of *Stachybotrys atra* in a structure is unremarkable, and other common indoor moulds such as *Acremonium, Alternaria, Arthrinium, Bipolaris, Chaetomium, Cladosporium* (the single most prevalent mould on the planet), *Claviceps, Cylindrocarpon, Diplodia, Fusarium, Gliocladium, Myrothecium, Paecilomyces, Phoma, Phomopsis, Pithomyces, Rhizoctonia, Rhizopus, Sclerotinia, Torula, Trichoderma, Trichothecium, Wallemia,* and *Zygosporium* (to name a few), all produce mycotoxins. OESI has provided no plausible explanation as to why it seems to have focused on the *Stachybotrys* genus.

DISCUSSION

Prior to considering an appropriate mould remediation program, one must first begin by defining one's objectives. Where an homeowner informs us that their objective is to have a mould-free house, we conclude that their objective is a physical impossibility, and there is no remediation plan that could ever achieve such a goal. All buildings on the planet earth contain mould.

ALL buildings in Colorado contain mould. Every building, every house, every attorney's office, every doctor's office and every hospital in Colorado contains the mould *Stachybotrys*. A similar statement may be made concerning the *Cladosporia*, the *Aspergilli*, and *Penicillia*. In our experience, the only people who get excited about finding these organisms, are those who either don't know their presence is normal, or who make their money by unnecessarily frightening homeowners with nonsensical and unscientifically founded talk of "toxic mould."

In its "reports" OESI makes several recommendations that are unwise and not supported by sound science or standard industry practices; viz:

Fogging

OESI recommends "Fogging with an antimicrobial solution to sanitize the air." This comment underscores the gross lack of technical competency by the authors of the report. Fogging would be considered **grossly** inappropriate and would be entirely incapable of achieving the stated goal of "sanitizing the air." To begin with, none of the samples collected indicated that an unusual spore count was present in the air. Therefore, by what metric would OESI suggest the efficacy of "fogging" be measured?

Since, overall, the highest spore counts were indicated in the outdoor air, is OESI suggesting fogging the outdoors?

The application of these materials is not consistent with normal accepted practice, and is inconsistent with good science which has demonstrated that the use of such materials provides no benefit. OESI, in its discussion references the US EPA. Yet, the EPA states:[84]

> *The use of a biocide, such as chlorine bleach, is* **not** *recommended as a routine practice during mold remediation, although there may be instances where professional judgment may indicate its use (for example, when immune-compromised individuals are present). In most cases, it is not possible or desirable to sterilize an area; a background level of mold spores will remain in the air (roughly equivalent to or lower than the level in outside air). These spores will not grow if the moisture problem in the building has been resolved*

Again, it appears that OESI has not actually read the documents they cited.

Finally, the wanton introduction of airborne chemicals designed to kill living things into residential structures or occupiable spaces should be avoided, not encouraged.

Scrubbing and Sanitizing

OESI states:

"*Scrub and sanitize any visible mold contaminated wood surfaces in the wall cavity.*"

We do not believe that OESI can provide any valid, tenable arguments to support this activity. Especially since it is known that sanitizing cannot be achieved, and the presence of mould in wall cavities (as already discussed) does not impact human exposures in occupied spaces.

Painting with Fosters IAQ Paint

FACTs has no specific knowledge of "Fosters IAQ Paint." However, we have encountered several poorly trained remediators to use various paints, sealers, and

[84] US EPA "*Mold Remediation in Schools and Commercial Buildings*" (2001),

encapsulants with the unsupported claims that the products somehow improve the remediation process. However, the use of these paints and encapsulants have the effect of reducing the hygric buffering capacity of the structure, thereby *increasing* the possibility of future mould growth problems where one otherwise may not exist.

We have seen several occasions where the application of these products has facilitated the growth of the dry rot fungus *S. lacrymans*, resulting in catastrophic failure of structural members.

CONCLUSIONS

The work performed by Ortiz Environmental Solutions Inc. appears to constitute junk science. The sampling performed by OESI was not performed according to acceptable sampling theory; did not rise to the level of a valid "mould test" or exposure assessment; was contrary to standard accepted protocols; and resulted in sample results that are generally meaningless and uninterpretable.

The OESI conclusions, based on their sampling and analysis, are generally foundationless, and cannot be supported by sound science or the sampling results; and several of the recommendations such as fogging and the application of fungicides are unwarranted, unwise, and not supported by standard industry practices or good remediation practices.

OESI appears to be oblivious of the contents of various documents they referenced, and they appear to be oblivious to the fact that those documents are contrary to their work.

The OESI report contains much that is based on popular myth and misconception and provides little, if any, tenable information regarding the presence of mould at the subject property or the significance of that presence.

The overall OESI report, in our opinion, exhibits a gross lack of technical competency in issues surrounding indoor mould assessments, aerobiology and sampling issues.

We found no indications in the documentations provided by the CVCA that unusual or excessive exposures to indoor moulds has occurred at the subject property.

We found no indications in the documentations provided by the CVCA that would support a prohibition on entry by the general public into any of the areas tested at the subject property.

Nothing within the document provided to FACTs by the CVCA suggest an unsafe environment vis-à-vis mould exposures at the subject property.

Nothing within the document provided to FACTs by the CVCA suggest an "environment of concern" vis-à-vis mould exposures at the subject property.

RECOMMENDATIONS

We recommend that a legitimate assessment for moulds be performed at the subject property by a legitimate industrial hygienist, professional engineer, building scientist, or other qualified professional. Such an evaluation can be completed without the collection of any samples for mould analysis.

We recommend that remediation activities progress in a common sense manner, consistent with good standard practices for water intrusion/restoration activities.

Caoimhín P. Connell
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May 2, 2008