

RESULTS OF INDOOR AIR QUALITY INVESTIGATION

NAVAL SEA SYSTEM COMMAND

WASHINGTON NAVY YARD

BUILDING 104

CONDUCTED FOR:

NAVSEA

SEPTEMBER 2001

ADVANCED ENVIRONMENTAL SERVICES, INC.

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EXECUTIVE SUMMARY

Naval Sea System Command (NAVSEA) issued a contract to Advanced Environmental Services, Inc. (AESI) for a baseline indoor air quality study at some of their buildings at the Navy Yard, Washington.

During the week of September 3-7, 2001, Dr. David Anderson of AESI toured the facilities and conducted preliminary baseline sampling. The facilities, for the most part, were recently remodeled and occupied by NAVSEA personnel, transferring in from Crystal City, Virginia. Some of these buildings were listed as historical sites.

NAVSEA personnel occupied building 104. The initial inspection and sampling of Building 104 was conducted on September 6, 2001. Minor visible mold was discovered under the Air Handling Units.

A total of nine (9) air samples for mold were collected inside the facility, and two (2) outside for comparison. The air samples were collected for mold using both Petri dishes (for viable organisms) and Zefon™ Air-O-Cell cassettes for total, non-viable airborne organisms; in addition, four (4) samples were collected for total Volatile Organic Chemicals (VOCs) in the air, including one outside. The samples were sealed and shipped via Fed Ex to an outside microbiological lab. The preliminary results were received via fax, with the final results received via mail.

Outside the air results were found to be high at 4,500 Counts per Cubic Meter of Air for total spores and 286 Colony Forming Units per Cubic Meter of Air (CFU / M³) of viable spores.

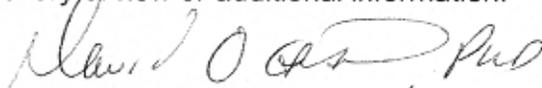
Air samples collected from inside Building 104 were significantly lower than the outside air – between 8 and 10 fold lower. No *Stachybotrys* was found. A swab sample of the mold found under the Air Handling Unit (AHU) revealed three (3) different types of mold, but at low concentrations.

The samples for VOCs were collected from the building. Several organic compounds were identified – but at low (micrograms of organic material per Cubic Meter of Air) concentrations, including 2-propanol, acetone, 1-2 butadiene, chloroethane, ethyl benzene, methyl ethyl ketone, and toluene.

A verbal report was issued to Mr. Michael Smith, COTR, with the preliminary data.

It appears that the mold and moisture levels are within the guidelines currently used, except for the penthouse with the AHUs. Minor remediation is suggested.

The report is based on information available to us at this time. No other aspects of indoor air quality (IAQ) were examined. AESI reserves the right to revise, supplement, and otherwise amend our opinions and conclusions, if necessary and warranted by the discovery of new or additional information.



David O. Anderson, Ph.D.
CIH, CSP, QEP, CPEA

January 23, 2002
Date Issued

INTRODUCTION, METHODOLOGIES, AND OBSERVATIONS

Naval Sea System Command (NAVSEA) issued a contract to Advanced Environmental Services, Inc. (AESI) for a baseline indoor air quality study at some of their buildings at the Navy Yard, Washington.

The purpose of the visit was to conduct a visual inspection of the interior, to collect airborne and bulk samples to establish a baseline for Indoor Air Quality measurements, to determine if a possible health risk was present and to recommend appropriate corrective actions.

The investigation was conducted in accordance with the recommendations and guidelines of the American Conference of Governmental Industrial Hygienists (ACGIH), the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), the Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), the Environmental Protection Agency (EPA), and established industry standards.

During the week of September 3-7, 2001, Dr. David Anderson of AESI toured the facilities and conducted preliminary baseline sampling with the assistance of the COTR, Michael Smith. The facilities, for the most part, were recently remodeled and occupied by NAVSEA personnel, transferring in from Crystal City, Virginia.

NAVSEA personnel occupied building 104, which originally appeared to have been two (2) buildings. These buildings were joined together with a roof, leaving a central "courtyard" area.

Outside, the weather was sunny and in the low 80's. Inside, the air conditioner was on and the temperature ranged from 69 to 72.5 degrees with a relative humidity of 38%. Visible mold was discovered under the Air Handling Unit (AHU) in the Penthouse, Room 3, 4th floor. No other visible mold was noted.

A total of nine (9) air samples for mold were collected inside the building, and two (2) outside for comparison. The air samples were collected for mold using both Petri dishes (for viable organisms) and ZefonTM Air-O-Cell cassettes for total, non-viable airborne organisms.

ZefonTM Air-O-Cell cassettes are used for total, non-viable airborne organisms. (For specific locations, please refer to Appendix A). Air-O-Cell cassettes collect samples for total organisms – both living (viable) and non-living (non-viable). The sampling pumps had been calibrated prior to arrival using a rotameter. These samples provide information on total fungal colony Counts per Cubic Meter (Counts / M³).

Petri Dish sample was also collected. The A-6 bioaerosol monitor, used to collect samples onto the Petri dish, was disinfected on-site using isopropyl alcohol. The air-sampling pump had been calibrated prior to the visit for the type of collection media using a standard method – wet test meter.

The samples collected in the Petri, which contained Potato Dextrose Agar (PDA) media, which allows for both cultivation and differentiation of spores, i.e. "viable". Following incubation, the samples are analyzed via light microscopy at 600X magnification, and the data are reported in numbers of Colony Forming Units per Cubic Meter of air (CFU / M³), as well as the specific genus types, such as *Aspergillus* and *Penicillium*. (Plates were shipped to the lab inside ice chests to minimize growth between collection and laboratory-controlled incubation).

One (1) bulk (swab) sample was also collected. The "swab" method uses a Sterile BBL Culture Swab collected over an approximately one hundred square centimeter surface area; the swab is placed into a plastic holder containing agar, sealed and labeled.

In addition, four (4) samples were collected for total Volatile Organic Chemicals (VOCs) in the air, including one outside. These samples used a 400 milliliter evacuated flask equipped with a flow-limiting orifice. Once activated, air was drawn into the prepared flask; following the sampling time, the flask was sealed. Upon arrival at the lab, the flask was purged and contents injected into a gas chromatograph equipped with a mass spectrometer; a total of sixty three (63) different organic compounds were analyzed for each VOC sample collected.

All samples were sealed and shipped via Fed-Ex to an outside, independent microbiological lab that specialized in identification and analyses of these types of samples; in addition, they also participate in an Environmental Microbiological Proficiency Analytical Testing (EMPAT) quality control program administered by the American Industrial Hygiene Association, designed for maximum quality and control. An affiliate lab that is Accredited by the American Industrial Hygiene Association analyzed the organic materials. Chain-of-Custody forms were maintained.

A Tramex moisture meter was used to measure moisture in the walls. Excessive moisture was not discovered. In the 4th floor elevator room, the hydraulic oil was in an open container; the odors were strong.

In addition, a TSI IAQ monitor was used to measure temperature, relative humidity, carbon monoxide (CO) and carbon dioxide (CO₂). The average temperature and relative humidity has already been mentioned. The average CO level was 0 parts per million (PPM), and the average CO₂ level was 645 PPM.

The preliminary results for the samples were received via fax, followed by mail. (Appendix B, sample numbers 1-6). A call was made to NAVSEA with the preliminary results in September 2001. Following additional lab results for VOCs reported later, an additional call was made to discuss the findings.

RESULTS AND DISCUSSION

Toxicological and Health Effects

Bioaerosols:

Bioaerosols include any biological agent, which becomes airborne. Bioaerosols may include pollens, animal dander, bacteria, as well as fungi. Because fungi are spore-bearing organisms, which are ideally suited for airborne transport, they often produce symptoms of discomfort among certain individuals.

Fungi originally were considered as a group of plants lacking any stems leaves or roots. Consequently, they were classified along with algae and the lichens. Fungi differed from those groups, however, in their lack of chlorophyll. Fungi exist as parasites (plant, animal and human pathogens) or as saprophytes (decomposers of non-living organic matter).

There are currently about 80,000 described species of fungi, both yeasts and molds, with probably more species awaiting discovery. Fungi are beneficial as food, as producers of antibiotics, as fermenting agents, as sources of drugs, as well as in many aspects of industry. Fungi are also well documented for their role in allergy.

Those fungi most responsible for causing allergy include species belonging to *Alternaria*, *Cladosporium*, *Aspergillus*, *Drechslera*, *Fusarium*, *Phoma*, *Epicoccum*, *Penicillium*, *Rhizopus*, *Mucor*, *Aureobasidium pullulans*, *Nigrospora*, *Scopulariopsis* and spores of rusts and smuts. *Cladosporium* is the most common fungus found in the air, followed by *Alternaria*, *Penicillium*, *Aspergillus*, *Fusarium*, and *Aureobasidium pullulans*. Clinically, the causative allergenic agents for most persons sensitive to fungi are *Cladosporium* and *Alternaria*.

Aspergillus, *Penicillium*, *Rhizopus*, *Mucor*, *Fusarium* and *Cladosporium* are examples of fungi that can produce a large number of spores. As they are present at all times in both the indoor and outdoor environments and are an important factor in the production of allergy in susceptible individuals.

Although fungi may grow and produce spores in the water and soil, dead organic debris is considered the main repository for aerobic fungi. Fungal spores will disperse from leaf litter, decaying plant material and other available organic substrata into the air and then fall onto vegetation where they may cause disease; are carried into homes and offices where they may cause moldy bathrooms and basements; and inhaled by humans and animals where they may cause toxic reactions, disease, an allergy, or other fungal disorders; fall onto leather, wood, or food, causing various mold damage; or fall back to or sail onto other supportive materials and repeat the cycle. In any case, fungi cannot produce their own food and therefore must find a source of organic matter in order to survive. High humidity is also necessary for fungal growth and spore germination.

It is important to note that airborne fungal spores must be viable to produce disease or to grow and germinate, but they do not have to be viable to produce allergenic effects in sensitive people. Although a bright sunny afternoon might substantially reduce the viability of fungal spores in the air, it will not bring relief to persons suffering from fungal allergy. There is some indication that the occupants of this residence may currently suffer from this allergic reaction.

Fungal spores are always present in the air, with rain and snow washing down most from the air, and the wind and sunshine causing an increase in the atmospheric distribution of spores. The number of airborne fungi is lowest during the winter months and highest during the summer and autumn months, when dead organic debris is more plentiful.

From the compilation of numerous data, the following distribution indicates the majority and frequency of fungal organisms typically isolated in indoor environments:

<u>Organism</u>	<u>Per Cent</u>
<i>Cladosporium</i>	100
<i>Penicillium</i>	91
<i>Alternaria</i>	87
<i>Epicoccum</i>	53
<i>Aspergillus sp.</i>	49
<i>Aureobasidium</i>	44
<i>Drechslera</i>	38
<i>Acremonium</i>	36
<i>Fusarium</i>	25
<i>Aspergillus niger</i>	19
<i>Rhizopus</i>	13

Possible health effects associated with fungi generally fall into one of three groups:

1. Allergic: sensitization and immune responses such as allergic rhinitis (hay fever), asthma, or hypersensitivity pneumonitis.
2. Infectious: growth of the fungus in or on the body, as with aspergillosis or histoplasmosis
3. Toxic: disruption of cellular function and interaction with DNA, as occurs with toxigenic effects, including aflatoxin-induced cancer.

Mycotoxins exert their effect on organisms in many ways including interference with cellular respiration, interference with carbohydrate and lipid metabolism, and direct binding with DNA and RNA. Several trichothecene mycotoxins are produced by *Stachybotrys*, and both *Aspergillus* and *Penicillium* can produce ochratoxin A. (For detailed explanations, please refer to Appendix C).

INTERPRETATIVE GUIDELINES

Previous research and test data have revealed that indoor airborne spore levels of 30 % to 70 % of the outdoor spore levels are normal, with the same general distribution of spore types. Filtered air, air-conditioned air, or air remote from outside sources may average 5 to 15 % of the outside air at the time of sampling. Based on these guidelines, a residence with open doors and windows and heavy foot traffic may average 135 % of the outdoor level while a high rise office building with little air exchange may average 2 %. In addition, dusty interiors may exceed 100 % of the outdoors to some degree, but will still mirror the outdoor distribution of spore types. Dusty conditions were not noted.

Data collected by the National Institute for Occupational Safety and Health (NIOSH) collectively suggest that a level of 1,000 total colony-forming units (cfu) per cubic meter of air (M^3) may warrant investigation and remedial action. The American Conference of Governmental Industrial Hygienists (ACGIH) Committee on Bioaerosols suggests that the indoor air-borne fungal spore concentration, either in Colony Forming Units or as Countable organisms, should not exceed 30 % of the outside levels and that the indoor level should be qualitatively similar to the outside level; currently there is no TLV for mold. During the growing season, according to the OSHA Technical Manual, levels of outdoor airborne fungal spore levels can range from 1,000 to 100,000 cfu/ M^3 . This reference goes on to indicate that airborne contaminant indicators are 1,000 cfu/ M^3 , but that levels above this do not necessarily imply that the conditions are unsafe or hazardous. Risk management investigation should be initiated if the following species are confirmed to be present: *Stachybotrys*, *Aspergillus versicolor*, *Aspergillus flavus*, *Aspergillus fumigatus*, and / or *Fusarium moniforme*.

In April 2000, the Indoor Air Quality Association published "Recommended Guidelines for Indoor Environments" (IAQA 01-2000). In this document, their recommendation for culturable (viable) fungal bioaerosols was 300 cfu/ M^3 for total and 50 cfu/ M^3 for individual fungal spores, excluding *Cladosporium*.

Currently in the United States, IAQ issues are not regulated by a governmental agency. The ACGIH recommends gathering the best data possible and using knowledge, experience, expert opinion, logic, and common sense interpretation of current information. As stated earlier, microbiological species present in the indoor environment should be generally representative of the species in the outdoor environment to a significantly lesser degree. The indoor air samples should not contain specific identifiable pathogenic microbiological organisms.

AIR-O-CELL:

The Air-O-Cell Cassette is a unique sampling device designed for the rapid collection and analysis of a wide range of airborne particles, including fungal spores. Air is drawn through a sampling cassette that contains a small, greased microscopic slide; the samples are analyzed via light microscopy at 600X magnification, with the entire slide (100% of the sample) being analyzed. The results are reported as **total**, meaning they include both viable (i.e., living) and non-viable fungal spores. This technique does not allow for the differentiation between *Aspergillus* and *Penicillium* spores, due to the small size. Small spherical fungal spores that cannot be identified and may include *Aspergillus*, *Penicillium*, and *Trichoderma* are grouped together as *Amerospores*. Additionally it does not allow for cultivation or speciation of spores. Typically the results from this collection and analysis method are higher than the Petri dish method, as all spores are collected and counted.

The sample results produced by the lab were received initially by fax and final copies via mail (Appendix B). Air-O-Cell Cassettes, Petri Dish, and VOC samples were collected in close proximity to each other.

AIR SAMPLE RESULTS:

Outside:

Air-O-Cell: The air sample results were found to be high at 4,500 Counts per Cubic Meter of Air for total spores – 33 % each of *Ascospores* and *Cladosporium*, 16 % *Basidiospores*, 12 % *Amerospores*, and six (6) other species at 1 %.

Petri Dish: Viable cultures revealed 286 Colony Forming Units per Cubic Meter of Air (CFU / M³) of viable spores were incubated and identified. 44 % of this sample was *Cladosporium*, 38 % *Penicillium*, and 3 other species at 6 % each.

VOC: (Collected by Building 28): The outside air sample revealed three compounds found – all in the part per billion ranges (ppb). They were Acetone (160 ppb), 2-Propanol (8.5 ppb), and Toluene (3 ppb).

Air samples collected from inside were lower than the outside air.

Fourth Floor (4S352)

- Air-O-Cell: The air sample results were found to be 40 Counts per Cubic Meter of Air for total spores – 33 % each of *Amerospores*, *Ascospores* and *Basidiospores*.
- Petri Dish: Viable cultures revealed 20 Colony Forming Units per Cubic Meter of Air (CFU / M³) of viable spores were incubated and identified - 33 % each of *Aspergillus*, *Curvularia*, and *Fusarium*.
- VOC: (Collected in the Elevator Room): The air sample revealed ten (10) different VOCs found. The chemicals found were Acetone (110 ppb), 2-Propanol (79 ppb), Propylene (52 ppb), 1,3-Butadiene (12 ppb), Chloroethane (11 ppb), m & p-Xylene (10 ppb), Toluene (7.3 ppb), MEK (7.2 ppb), o-Xylene (3.1 ppb), and Ethyl benzene (3.0 ppb)

Fourth Floor (4N604)

- Air-O-Cell: The air sample results were found to be 53 Counts per Cubic Meter of Air for total spores - 75 % *Basidiospores* and 25 % *Aspergillus* / *Penicillium*.

Fourth Floor Room 3 (AHU)

- Air-O-Cell: The air sample results were found to be 80 Counts per Cubic Meter of Air for total spores - 83 % *Aspergillus* / *Penicillium* and 17 % *Cladosporium*.

Third Floor (3S752)

- Air-O-Cell: The air sample results were found to be 53 Counts per Cubic Meter of Air for total spores – 50 % each of *Ascospores* and *Cladosporium*.
- Petri Dish: Viable cultures revealed 27 Colony Forming Units per Cubic Meter of Air (CFU / M³) of viable spores were incubated and identified - 50 % *Cladosporium*, and 25 % each of *Aspergillus* and *Curvularia*.

Second Floor (2N401)

- Air-O-Cell: The air sample results were found to be 67 Counts per Cubic Meter of Air for total spores – 40 % each of *Ascospores* and *Basidiospores*, and 20 % Smuts.
- Petri Dish: Viable cultures revealed 27 Colony Forming Units per Cubic Meter of Air (CFU / M³) of viable spores were incubated and identified - 33 % each of *Alternaria*, *Cladosporium* and *Curvularia*.

First Floor:

- Air-O-Cell (Main Conference Room): The air sample results were found to be 13 Counts per Cubic Meter of Air for total spores – all *Basidiospores*.
- VOC: (Atrium): The air sample revealed four (4) different VOCs. The chemicals found were Acetone (150 ppb), 2-Propanol (13 ppb), Chloroethane (12 ppb), and m & p-Xylene (5.1 ppb).

BULK SAMPLE:

One (1) bulk sample was collected using a swab. The sample was collected from under the AHU in Room 3, 4th Floor. This sample was reported by the lab to contain 1 – 5 % each of *Amerospores*, *Ascospores*, and *Nigrospora*.

CONCLUSIONS

This baseline survey revealed that, on the date of the testing, the overall air quality indoors was better than the air quality outside. Several minor issues were discovered, including problems with the Elevator Room on the 4th floor, and water drainage from condensation in Room 3 under the AHU.

RECOMMENDATIONS

Fourth Floor: The Elevator Room should be exhausted to the outside air and / or the open vat of hydraulic fluid sealed to reduce odors. One of the chemicals identified – 1,3 Butadiene – is a regulated carcinogen under OSHA (29 CFR 1910.1051); however, the level measured was in the part per billion range (12 ppb), while the OSHA allowable level is in 1 part per million for an 8-hour day, with an action level of 0.5 ppm (500 ppb).

The condensation drainage system for the AHUs should be corrected to allow for piping to carry moisture directly into the drain, and not run across the floor.

Follow-up to these suggestions is also suggested.

Appendix A

Sampling Locations

Sampling Locations

Sample Number	Sample Type	Location
1	Air-O-Cell	4S352
2	Petri Dish	4S352
3	Air-O-Cell	4N604
4	VOC	4 th Floor Elevator Room
5	Air-O-Cell	4 th Floor, Room 3
6	Swab	Under AHU, Room 3
7	Air-O-Cell	Inside Fire Water Closet, Southeast Corner
8	Petri	3S752
9	Air-O-Cell	3S752
10	Petri	2N401
11	VOC	Atrium
12	Air-O-Cell	Main Conference Room
13	Air-O-Cell	Outside
14	Petri	Outside
15	VOC	Outside, by Building 28

Appendix B

Microbiological Results

And

Lab Data



AEROTECH LABORATORIES, INC.

Lab Number: A-109-0685
 Project Name: NYW
 Project Number: 0880-104
 Date Received: 09/07/01
 Date Reported: 09/12/01

AIHA Empat No. 102297
 Air-O-Cell Cassette Analysis
 Aerotech Method: A001

AESI
 1112 Charleston Ct.
 Keller, TX 76248
 Attn: Dr. David Anderson

Lab Number	1			3			5			
	Sample Identification	AOC 0881 - 45352	AOC 0800 - 4N604	AOC 0850 4th Flr Rm3	Volume (M ³)	0.0750	0.0750	0.0750	Date Analyzed	09/10/2001
Percent Of Trace Analyzed	100% of Trace at 600X Magnification			100% of Trace at 600X Magnification			100% of Trace at 600X Magnification			
Debris Rating	2			3			3			
Mycelial Fragments	Total Count	Count/M ³		Total Count	Count/M ³		Total Count	Count/M ³		
		Result	Detection Limit		Result	Detection Limit		Result	Detection Limit	
	2	27	13	3	40	13	2	27	13	
Pollen Count	Total Count	Count/M ³		Total Count	Count/M ³		Total Count	Count/M ³		
		Result	Detection Limit		Result	Detection Limit		Result	Detection Limit	
	1	13	13	1	13	13	<1	<13	13	
Total Fungal Spores	3	40	13	4	53	13	6	80	13	
Fungal Spore Identification										
<i>Alternaria</i>										
Amerospores	1	13	13							
<i>Arthrinium</i>										
Ascospores	1	13	13	1	13	13	5	67	13	83
<i>Aspergillus/Penicillium</i>										
<i>Aureobasidium</i>										
Basidiospores	1	13	13	3	40	13				
<i>Bipolaris/Dreschlera</i>										
<i>Botrytis</i>										
<i>Chaetomium</i>										
<i>Cladosporium</i>										
<i>Curvularia</i>							1	13	13	17
<i>Epicoccum</i>										
<i>Fusarium</i>										
<i>Nigrospora</i>										
<i>Oidium/Peronospora</i>										
<i>Pithomyces/Ulocladium</i>										
Rusts										
<i>Smuts/Myxomycetes</i>										
<i>Stachybotrys</i>										
<i>Stemphylium</i>										
<i>Torula</i>										
Unidentified Conidia										
Notes:										

Prepared By: [Signature]
 CS Review: [Signature]

Technical Review: [Signature]
 Final Review: [Signature]



AEROTECH LABORATORIES, INC.

Lab Number: A-109-0685
Project Name: NYW
Project Number: 0880-104
Date Received: 09/07/01
Date Reported: 09/12/01

AIHA Empat No. 102297
Microscopic Screen and Fungi Identification
Aerotech Method: S001

AESI
1112 Charleston Ct.
Keller, TX 76248
Attn: Dr. David Anderson

Lab Number	6
Sample Identification	Swab Under ACU Rm 3
Date Analyzed	09/10/2001
	Results
Mycelial Fragments	1-5%
Fungal Spores	1-5%
	Fungal Spore Identification
<i>Alternaria</i>	
Amerospores	1-5%
<i>Arthrinium</i>	
Ascospores	1-5%
<i>Aspergillus/Penicillium</i>	
<i>Aureobasidium</i>	
Basidiospores	
<i>Bipolaris/Dreschlera</i>	
<i>Botrytis</i>	
<i>Chaetomium</i>	
<i>Cladosporium</i>	
<i>Curvularia</i>	
<i>Epicoccum</i>	
<i>Fusarium</i>	
<i>Nigrospora</i>	1-5%
<i>Oidium/Peronospora</i>	
<i>Pithomyces/Ulocladium</i>	
Rusts	
<i>Smuts/Myxomycetes</i>	
<i>Stachybotrys</i>	
<i>Stemphylium</i>	
<i>Torula</i>	
Unidentified Conidia	
Notes:	

Technical Review: *cmh*
Final Review: *cmh*

Prepared By: *APB*
CS Review: *SB*



AEROTECH LABORATORIES, INC.

Lab Number: A-109-0685
 Project Name: NYW
 Project Number: 0880-104
 Date Received: 09/07/01
 Date Reported: 09/12/01

AIHA Empat No. 102297
 Air-O-Cell Cassette Analysis
 Aerotech Method: A001

AESE
 1112 Charleston Ct.
 Keller, TX 76248
 Attn: Dr. David Anderson

Sample Identification	Count/M ³		
	Total Count	Result	Detection Limit
Lab Number	13		
Sample Identification	AOC 0888 Out		
Volume (M ³)	0.0300		
Date Analyzed	09/10/2001		
Percent Of Trace Analyzed	100% of Trace at 600X Magnification		
Debris Rating	3		
			%
Mycelial Fragments	4	133	33
Pollen Count	5	167	33
Total Fungal Spores	135	4,500	33
	Fungal Spore Identification		
Alternaria	1	33	33
Amerospores	16	533	33
Arthrinium	1	33	33
Ascospores	45	1,500	33
Aspergillus/Penicillium			
Aureobasidium			
Basidiospores	22	733	33
Bipolaris/Dreschlera	1	33	33
Botrytis			
Chaetomium	1	33	33
Cladosporium	45	1,500	33
Curvularia			
Epicoccum			
Fusarium			
Nigrospora	1	33	33
Oidium/Peronospora			
Pithomyces/Ulocladium			
Rusts			
Smuts/Myxomycetes			
Stachybotrys			
Stemphylium			
Torula	2	67	33
Unidentified Conidia			
Notes:			

Technical Review: *[Signature]*
 Final Review: *[Signature]*

Prepared By: AB
 CS Review: SB



AEROTECH LABORATORIES, INC.

Lab Number: A-109-0685
 Project Name: NYW
 Project Number: 0680-104
 Date Received: 09/07/01
 Date Reported: 09/21/01

AIHA Empat No. 102297
Viable Fungi Analysis - Air
 Aerotech Method: A003

AESI
 1112 Charleston Ct.
 Keller, TX 76248
 Attn: Dr. David Anderson

Sample Identification	14		CFU	Result	Detection Limit	%
	Petri Out					
Date Incubated	09/07/2001		16	286	18	100
Date Analyzed	09/20/2001					
Culture Media	Potato Dextrose (PDA)					
Volume (M ³)	0.0560					
Viable Fungi 20-25°C						
<i>Acromonium</i>			1	18	18	6
<i>Aspergillus fumigatus</i>						
<i>Aspergillus niger</i>						
<i>Aspergillus species Var. 1</i>						
<i>Aspergillus species Var. 2</i>						
<i>Aureobasidium</i>						
<i>Bipolaris</i>						
<i>Chaetomium</i>						
<i>Chrysosporium</i>			7	125	18	44
<i>Cladosporium</i>						
<i>Cunninghamella</i>						
<i>Curvularia</i>			1	18	18	6
<i>Epicoccum</i>						
<i>Fusarium</i>			1	18	18	6
<i>Geotrichum</i>						
<i>Mucor</i>						
<i>Mycelia sterilia</i>						
<i>Paecilomyces</i>						
<i>Penicillium species Var. 1</i>			6	107	18	33
<i>Penicillium species Var. 2</i>						
<i>Phoma</i>						
<i>Rhizopus</i>						
<i>Sporotrichum</i>						
<i>Stachybotrys</i>						
<i>Stemphylium</i>						
<i>Trichoderma</i>						
<i>Ulocladium</i>						
<i>Yeast</i>						

Notes:

Prepared By: [Signature]
 CS Review: [Signature]

Technical Review: [Signature]
 Final Review: [Signature]



AEROTECH LABORATORIES, INC.

Tuesday, September 11, 2001

Dr. David Anderson
AESI
1112 Charleston Ct.
Keller, TX 76248

Re: Aerotech Project Number A-109-0685

Dear Dr. David:

Aerotech is pleased to provide the enclosed report of analyses for samples submitted Friday, September 07, 2001. This cover letter and accompanying pages are an integral part of this report. All analyses are performed in our AIHA proficiency-tested laboratory under the FDA Good Laboratory Practice Guidelines and the parameters outlined in the most current version of the American Conference of Governmental Industrial Hygienists Bioaerosol Guidelines. The data generated in this report is based on the samples and accompanying information provided. Aerotech employees did not collect samples for this project, and may provide limited interpretation of this data as it relates to the overall investigation.

Quality Assurance

Aerotech is staffed by certified microbiologists, maintains a rigorous Quality Assurance program and participates in the American Industrial Hygiene Association's Environmental Microbiology Proficiency Testing Program. Our AIHA EMPAT Number is 102297. Aerotech is extremely proud of its excellent scoring in this program and will provide copies of our results upon request. They can also be downloaded from our web site at www.aerotechlabs.com. Below you will find additional information regarding the specific analyses requested for this project.

A001, A002, WC001

Air-O-Cell Cassette

The Air-O-Cell Cassette is a unique sampling device designed for the rapid collection and analysis of a wide range of airborne particles, including fungal spores. Samples are analyzed via light microscopy at 600X magnification, with the entire slide (100% of the sample) being analyzed. The results are reported as **total**, meaning they include both viable and non-viable fungal spores. Unfortunately, this technique does not allow for the differentiation between *Aspergillus* and *Penicillium* spores. Small (~1-3 μ) spherical fungal spores that cannot be identified and may include *Aspergillus*, *Penicillium*, and *Trichoderma* and others are grouped together as *Amerospores*. Additionally it does not allow for cultivation or speciation of spores. Slides containing greater than 500 fungal spores are difficult to count accurately due to overcrowding and are therefore estimations. Similarly, excessive non-microbial particulates can mask the presence of fungal spores, thereby reducing counting accuracies. All slides are graded with the following debris scale for data qualification.

Debris Rating Scale

Non-Microbial Particulate Debris Rating	Description	Interpretation
0	No particles detected	No particulates in on slide. The absence of particulates could indicate improper sampling, as most air samples typically contain some particulates
1	Minimal non-microbial debris present.	Reported values are not affected by debris.
2	Up to 25% of the slide occluded with non-microbial particulates.	Non-microbial particulates can mask the presence of fungal spores. As a result, actual values could be up to 1.3 times higher than reported.
3	26% to 75% of the slide occluded with non-microbial particulates.	Non-microbial particulates can mask the presence of fungal spores. As a result, actual values could be up to 1.4 to 4 times higher than reported
4	76% to 90% of the slide occluded with non-microbial particulates.	Non-microbial particulates can mask the presence of fungal spores. As a result, actual values could be up to 4 to 10 times higher than reported.
5	Greater than 90% of the slide occluded with non-microbial particulates.	Quantification not possible. Resamples should be collected at shorter time interval, or other measures taken to reduce the collection of non-microbial debris.

B001, S001

Microscopic Screen

A microscopic screen is a rapid analytical technique for confirming the presence and identity of fungi on a surface. The results are expressed as a percentage range relative to the prevalence and concentration of fungi in the sample. Samples are analyzed via light microscopy at 600X magnification. The results are reported as **total**, meaning they include both viable and non-viable fungal spores. Unfortunately, this technique does not allow for the differentiation between *Aspergillus* and *Penicillium* spores. Small (~1-3 μ) spherical fungal spores that cannot be identified and may include *Aspergillus*, *Penicillium*, and *Trichoderma* are grouped together as *Amerospores*. Additionally this analysis does not allow for cultivation or speciation of spores.

A003, A004, A005, A006, B002, B003, B004, B007, CC002, CC003, CC004, CC005, S002, S003, S004, S007
W001, W002, W003, W004

Culture Analyses for Fungi and Bacteria

Cultureable microorganisms are those that are viable when media is inoculated, and will grow on the selected media and at the selected temperature. This technique has certain limitations when analyzing for certain types of fungi, specifically *Stachybotrys*. Some reports indicate that the recovery efficiency of *Stachybotrys* spores can be as low as 10% when compared to total spore techniques.

The type of media and incubation temperature can vary depending on the scope of the survey. Isolates are identified to the service level requested. Typical analysis includes identification of most fungi to the genus level. *Aspergillus* and *Penicillium* species are differentiated based on morphology with each variant reported separately. Identification to the species level can be performed if requested in advance. General incubation parameters are summarized below. Incubation times can vary depending on specific growth characteristics. Samples submitted for culture analysis using Cornmeal Agar (CMA) or Cellulose Agar are cultured for 14 days.

Test	Incubation Temperature (° C)	Incubation Time
Environmental Bacteria	28	48 hours
Total Fungi	20-25	7-10 days
Thermophilic fungi	37	7-10 days
Thermophilic Actinomycetes	50	48 hours

Common Culture Media

Acronym	Name
BAP	Tryptic Soy Agar with 5% Sheep Blood
PCA	Plate Count Agar
R2A	R2A
BCYE	Buffered Charcoal Yeast Extract Agar
PDA	Potato Dextrose Agar
MEA	Malt Extract Agar
DG-18	Dichloran Glycerol Agar
SAB	Sabauroud's Dextrose Agar
RBA	Rose Bengal Agar
CYA	Czapeck's Yeast Agar

This communication is intended only for the individual or entity to which it is directed. It may contain information that is privileged, confidential, or otherwise exempt from disclosure under applicable law. Dissemination, distribution, or copying of this communication by anyone other than the intended recipient, or a duly designated employee or agent of such recipient, is prohibited. If you have received this communication in error, please notify us immediately by telephone at 800.651.4802, and delete this message and all attachments thereto.

For additional information, or if you have any questions regarding this report, please do not hesitate to call.

Sincerely,

Ruth Skinner
Project Manager
Aerotech Laboratories, Inc.
800-651-4802

Analytical References

1. Medically Important Fungi: A Guide to Identification, 3rd ed., ASM, 1995.
2. Standard Methods for the Examination of Water and Wastewater, 19th ed., APHA, 1995.
3. Sampling and Identifying Allergenic Pollens and Molds, Blewstone, 1990.
4. Identifying Filamentous Fungi: A Clinical Laboratory Handbook, Star, 1996.
5. Manual of Clinical Microbiology, 7th ed., ASM, 1999.
6. A Laboratory Guide to Common *Aspergillus* Species and their Teleomorphs, CSIRO, 1994.
7. Bioaerosols: Assessment and Control, ACGIH, 1999.



AEROTECH LABORATORIES, INC.

AESI
 1112 Charleston Ct.
 Keller, TX 76248
 Attn: David Anderson

Lab Number: A-109-0685-4
 Project ID: 0880-104
 Sample ID: VOC 4th Flr
 Sample Size: 400 mL Can
 Date Received: 09/07/01
 Date Analyzed: 09/07/01
 Date Reported: 09/14/01

Volatile Organic Compounds (VOC's) - Air

EPA TO14A/TO15

Results			
Compound	ppbv	µg/m ³	Comments
1,1,1-Trichloroethane	<2.0	<11.1	
1,1,2,2-Tetrachloroethane	<2.0	<14	
1,1,2-Trichloroethane	<2.0	<11.1	
1,1-Dichloroethane	<2.0	<8.2	
1,1-Dichloroethene	<2.0	<8.1	
1,2,4-Trichlorobenzene	<2.0	<15	
1,2,4-Trimethylbenzene	<2.0	<10	
1,2-Dibromoethane	<2.0	<15.6	
1,2-Dichlorobenzene	<2.0	<12.2	
1,2-Dichloroethane	<2.0	<8.2	
1,2-Dichloropropane	<2.0	<9.4	
1,3,5-Trimethylbenzene	<2.0	<10	
1,3-Butadiene	12	26.9	
1,3-Dichlorobenzene	<2.0	<12.2	
1,4-Dichlorobenzene	<2.0	<12.2	
2,2,4-Trimethylpentane	<2.0	<9.5	
2-Butanone (MEK)	7.2	21.6	
2-Hexanone	<2.0	<8.3	
2-Propanol	79	197	
4-Ethyltoluene	<2.0	<8.8	
4-Methyl-2-pentanone	<4.0	<16.6	
Acetone	110	265.2	
Allyl chloride	<2.0	<6.4	
Benzene	<2.0	<6.5	
Benzyl chloride	<2.0	<10.6	
Bromodichloromethane	<2.0	<13.6	
Bromoethene(Vinyl Bromide)	<2.0	<8.9	
Bromoform	<2.0	<21	
Bromomethane	<2.0	<7.9	
Carbon disulfide	<2.0	<6.3	
Carbon tetrachloride	<2.0	<12.8	
Chlorobenzene	<2.0	<9.4	
Chloroethane	11	29.5	
Chloroform	<2.0	<9.9	
Chloromethane	<2.0	<4.2	
cis-1,2-Dichloroethene	<2.0	<8	
cis-1,3-Dichloropropene	<2.0	<9.2	
Cyclohexane	<2.0	<7	

Input By: AB
 CS Review: CH

Technical Review: al
 Final Review: [Signature]



AEROTECH LABORATORIES, INC.

AESI
 1112 Charleston Ct.
 Keller, TX 76248
 Attn: David Anderson

Lab Number: A-109-0685-4
 Project ID: 0880-104
 Sample ID: VOC 4th Flr
 Sample Size: 400 mL Can
 Date Received: 09/07/01
 Date Analyzed: 09/07/01
 Date Reported: 09/14/01

Volatile Organic Compounds (VOC's) - Air

EPA TO14A/TO15

Results			
Compound	ppbv	µg/m ³	Comments
Dibromochloromethane	<2.0	<17.3	
Dichlorodifluoromethane(F-12)	<2.0	<10.1	
Dichlorotetrafluoroethane(F-11)	<2.0	<11.4	
Ethyl Acetate	<2.0	<7.3	
Ethylbenzene	3	13.2	
Heptane	<2.0	<8.3	
Hexachlorobutadiene	<2.0	<21.7	
Hexane	<2.0	<7.2	
m&p-Xylene	10	44.1	
Methyl tert-butyl ether	<4.0	<14.6	
Methylene chloride	<2.0	<7.1	
o-Xylene	3.1	13.7	
Propene (Propylene)	52	90.8	
Styrene	<2.0	<8.6	
Tetrachloroethene	<2.0	<13.8	
Tetrahydrofuran	<4.0	<12	
Toluene	7.3	27.9	
trans-1,2-Dichloroethene	<2.0	<8	
trans-1,3-Dichloropropene	<2.0	<9.2	
Trichloroethene	<2.0	<10.9	
Trichlorofluoromethane	<2.0	<11.4	
Trichlorotrifluoroethane	<2.0	<15.5	
Vinyl acetate	<2.0	<7.2	
Vinyl chloride	<2.0	<5.2	

Non-Target Analytes

Estimated Concentration (ppbv)	Number Of Compounds Detected
0-50	0
50-200	0
Greater than 200	0

Input By: *AD*
 CS Review: *CH*

Technical Review: *ad*
 Final Review: *[Signature]*

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AEROTECH LABORATORIES, INC.

AESI
1112 Charleston Ct.
Keller, TX 76248
Attn: David Anderson

Lab Number: A-109-0685-11
Project ID: 0880-104
Sample ID: VOC Atrium
Sample Size: 400 mL Can
Date Received: 09/07/01
Date Analyzed: 09/07/01
Date Reported: 09/14/01

Volatile Organic Compounds (VOC's) - Air

EPA TO14A/TO15

Compound	Results		Comments
	ppbv	$\mu\text{g}/\text{m}^3$	
1,1,1-Trichloroethane	<2.0	<11.1	
1,1,2,2-Tetrachloroethane	<2.0	<14	
1,1,2-Trichloroethane	<2.0	<11.1	
1,1-Dichloroethane	<2.0	<8.2	
1,1-Dichloroethene	<2.0	<8.1	
1,2,4-Trichlorobenzene	<2.0	<15	
1,2,4-Trimethylbenzene	<2.0	<10	
1,2-Dibromoethane	<2.0	<15.6	
1,2-Dichlorobenzene	<2.0	<12.2	
1,2-Dichloroethane	<2.0	<8.2	
1,2-Dichloropropane	<2.0	<9.4	
1,3,5-Trimethylbenzene	<2.0	<10	
1,3-Butadiene	<2.0	<4.5	
1,3-Dichlorobenzene	<2.0	<12.2	
1,4-Dichlorobenzene	<2.0	<12.2	
2,2,4-Trimethylpentane	<2.0	<9.5	
2-Butanone (MEK)	<2.0	<6	
2-Hexanone	<2.0	<8.3	
2-Propanol	13	32.4	
4-Ethyltoluene	<2.0	<8.8	
4-Methyl-2-pentanone	<4.0	<16.6	
Acetone	150	361.7	
Allyl chloride	<2.0	<6.4	
Benzene	<2.0	<6.5	
Benzyl chloride	<2.0	<10.6	
Bromodichloromethane	<2.0	<13.6	
Bromoethene(Vinyl Bromide)	<2.0	<8.9	
Bromoform	<2.0	<21	
Bromomethane	<2.0	<7.9	
Carbon disulfide	<2.0	<6.3	
Carbon tetrachloride	<2.0	<12.8	
Chlorobenzene	<2.0	<9.4	
Chloroethane	12	32.2	
Chloroform	<2.0	<9.9	
Chloromethane	<2.0	<4.2	
cis-1,2-Dichloroethene	<2.0	<8	
cis-1,3-Dichloropropene	<2.0	<9.2	
Cyclohexane	<2.0	<7	

Input By: *UB*
CS Review: *CH*

Technical Review: *al*
Final Review: *Paula Sr*

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AEROTECH LABORATORIES, INC.

AESI
 1112 Charleston Ct.
 Keller, TX 76248
 Attn: David Anderson

Lab Number: A-109-0685-11
 Project ID: 0880-104
 Sample ID: VOC Atrium
 Sample Size: 400 mL Can
 Date Received: 09/07/01
 Date Analyzed: 09/07/01
 Date Reported: 09/14/01

Volatile Organic Compounds (VOC's) - Air

EPA TO14A/TO15

Compound	Results		Comments
	ppbv	µg/m ³	
Dibromochloromethane	<2.0	<17.3	
Dichlorodifluoromethane(F-12)	<2.0	<10.1	
Dichlorotetrafluoroethane(F-11)	<2.0	<11.4	
Ethyl Acetate	<2.0	<7.3	
Ethylbenzene	<2.0	<8.8	
Heptane	<2.0	<8.3	
Hexachlorobutadiene	<2.0	<21.7	
Hexane	<2.0	<7.2	
m&p-Xylene	5.1	22.5	
Methyl tert-butyl ether	<4.0	<14.6	
Methylene chloride	<2.0	<7.1	
o-Xylene	<2.0	<8.8	
Propene (Propylene)	<2.0	<3.5	
Styrene	<2.0	<8.6	
Tetrachloroethene	<2.0	<13.8	
Tetrahydrofuran	<4.0	<12	
Toluene	<2.0	<7.7	
trans-1,2-Dichloroethene	<2.0	<8	
trans-1,3-Dichloropropene	<2.0	<9.2	
Trichloroethene	<2.0	<10.9	
Trichlorofluoromethane	<2.0	<11.4	
Trichlorotrifluoroethane	<2.0	<15.5	
Vinyl acetate	<2.0	<7.2	
Vinyl chloride	<2.0	<5.2	

Non-Target Analytes

Estimated Concentration (ppbv)	Number Of Compounds Detected
0-50	0
50-200	0
Greater than 200	0

Input By: *AB*
 CS Review: *CH*

Technical Review: *ak*
 Final Review: *Paul Sr.*

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AEROTECH LABORATORIES, INC.

AESI
1112 Charleston Ct.
Keller, TX 76248
Attn: David Anderson

Volatile Organic Compounds (VOC's) - Air

EPA TO14A/TO15

Lab Number: A-109-0685-15
Project ID: 0880-104
Sample ID: VOC Bldg 28
Sample Size: 400 mL Can
Date Received: 09/07/01
Date Analyzed: 09/07/01
Date Reported: 09/14/01

Results			
Compound	ppbv	µg/m ³	Comments
1,1,1-Trichloroethane	<2.0	<11.1	
1,1,2,2-Tetrachloroethane	<2.0	<14	
1,1,2-Trichloroethane	<2.0	<11.1	
1,1-Dichloroethane	<2.0	<8.2	
1,1-Dichloroethene	<2.0	<8.1	
1,2,4-Trichlorobenzene	<2.0	<15	
1,2,4-Trimethylbenzene	<2.0	<10	
1,2-Dibromoethane	<2.0	<15.6	
1,2-Dichlorobenzene	<2.0	<12.2	
1,2-Dichloroethane	<2.0	<8.2	
1,2-Dichloropropane	<2.0	<9.4	
1,3,5-Trimethylbenzene	<2.0	<10	
1,3-Butadiene	<2.0	<4.5	
1,3-Dichlorobenzene	<2.0	<12.2	
1,4-Dichlorobenzene	<2.0	<12.2	
2,2,4-Trimethylpentane	<2.0	<9.5	
2-Butanone (MEK)	<2.0	<6	
2-Hexanone	<2.0	<8.3	
2-Propanol	8.5	21.2	
4-Ethyltoluene	<2.0	<8.8	
4-Methyl-2-pentanone	<4.0	<16.6	
Acetone	160	385.8	
Allyl chloride	<2.0	<6.4	
Benzene	<2.0	<6.5	
Benzyl chloride	<2.0	<10.6	
Bromodichloromethane	<2.0	<13.6	
Bromoethene(Vinyl Bromide)	<2.0	<8.9	
Bromoform	<2.0	<21	
Bromomethane	<2.0	<7.9	
Carbon disulfide	<2.0	<6.3	
Carbon tetrachloride	<2.0	<12.8	
Chlorobenzene	<2.0	<9.4	
Chloroethane	<2.0	<5.4	
Chloroform	<2.0	<9.9	
Chloromethane	<2.0	<4.2	
cis-1,2-Dichloroethene	<2.0	<8	
cis-1,3-Dichloropropene	<2.0	<9.2	
Cyclohexane	<2.0	<7	

Input By: AB
CS Review: CH

Technical Review: *ak*
Final Review: *Paul Si*

A010 Page 1 of 2



AEROTECH LABORATORIES, INC.

AESI
 1112 Charleston Ct.
 Keller, TX 76248
 Attn: David Anderson

Lab Number: A-109-0685-15
 Project ID: 0880-104
 Sample ID: VOC Bldg 28
 Sample Size: 400 mL Can
 Date Received: 09/07/01
 Date Analyzed: 09/07/01
 Date Reported: 09/14/01

Volatile Organic Compounds (VOC's) - Air

EPA TO14A/TO15

Results			
Compound	ppbv	µg/m ³	Comments
Dibromochloromethane	<2.0	<17.3	
Dichlorodifluoromethane(F-12)	<2.0	<10.1	
Dichlorotetrafluoroethane(F-11)	<2.0	<11.4	
Ethyl Acetate	<2.0	<7.3	
Ethylbenzene	<2.0	<8.8	
Heptane	<2.0	<8.3	
Hexachlorobutadiene	<2.0	<21.7	
Hexane	<2.0	<7.2	
m&p-Xylene	<4.0	<17.6	
Methyl tert-butyl ether	<4.0	<14.6	
Methylene chloride	<2.0	<7.1	
o-Xylene	<2.0	<8.8	
Propene (Propylene)	<2.0	<3.5	
Styrene	<2.0	<8.6	
Tetrachloroethene	<2.0	<13.8	
Tetrahydrofuran	<4.0	<12	
Toluene	3	11.5	
trans-1,2-Dichloroethene	<2.0	<8	
trans-1,3-Dichloropropene	<2.0	<9.2	
Trichloroethene	<2.0	<10.9	
Trichlorofluoromethane	<2.0	<11.4	
Trichlorotrifluoroethane	<2.0	<15.5	
Vinyl acetate	<2.0	<7.2	
Vinyl chloride	<2.0	<5.2	

Non-Target Analytes

Estimated Concentration (ppbv)	Number Of Compounds Detected
0-50	0
50-200	0
Greater than 200	0

Input By: AB
 CS Review: CH

Technical Review: *al*
 Final Review: *ant*

A010 Page 2 of 2

Appendix C

Fungal Glossary

FUNGAL GLOSSARY

Acremonium sp. (Cephalosporium sp.) - Reported to be allergenic. Can produce a trichothecene toxin that is toxic if ingested. It was the primary fungus identified in at least two houses where the occupant complaints were nausea, vomiting and diarrhea. The asexual state of *Emericellopsis sp.*, *Chaetomium sp.*, and *Nectriopsis sp.*, it can produce mycetomas, infections of the cornea and nails.

Alternaria sp. - Conidia dimensions 18-83 x 7-18 microns. A very common allergen with an IgE mediated response. It is often found in carpets, textiles, and on horizontal surfaces in building interiors. Often found on window frames. Outdoors it may be isolated from samples of soil, seeds and plants. It is commonly found in outdoor samples. The large spore size 20 - 200 microns in length and 7 - 18 microns in sizes, suggests that the spores from this fungi will deposited in the nose, mouth and upper respiratory tract. It may be related to "Baker's Asthma." It has been associated with hypersensitivity pneumonitis. The species *Alternaria alternata* is capable of producing tenuazonic acid and other toxic metabolites, which may be associated with disease in humans or animals. Common cause of extrinsic asthma (immediate-type hypersensitivity: type I). Acute symptoms include edema and bronchospasms; chronic cases may develop pulmonary emphysema.

Aspergillus flavus - Conidia dimensions 3-6 microns. It grows on moldy corn and peanuts. It can be found in warm soil, foods and dairy products. Some strains are capable of producing a group of mycotoxins - in the aflatoxin group. Aflatoxins are known animal carcinogen. There is limited evidence to suggest that this toxin is a human carcinogen. The toxin is a poisonous to humans by ingestion. It may also result in occupational disease via inhalation. Experiments have indicated that it is teratogenic and mutagenic. It is toxic to the liver. It is reported to be allergenic. Its presence is associated with reports of asthma. It can be found in water-damaged carpets. The production of the fungal toxin is dependent on the growth conditions and on the substrate used as a food source. This fungus is associated with aspergillosis of the lungs and/or disseminated aspergillosis. This fungus is occasionally identified as the cause of corneal, otomycotic and naso-orbital infections.

Aspergillus fumigatus - Conidia dimensions 2-3.5 microns. Major cause of aspergillosis. This organism causes both invasive and allergic aspergillosis. Aspergillosis affects individuals who are immune compromised. It is considered a human pathogen. It grows well at 35 ° C. It is commonly found outdoors in compost piles with temperatures higher than 40 ° C, in mild to warm soils and on cereals.

Aspergillus nidulans - Conidia dimensions 2-4 microns. Found in mild to warm soils and on slowly decaying plants. Can produce the mycotoxin sterigmatocystin. This toxin has been shown to produce liver and kidney damage in lab animals. This fungus is associated with aspergillosis of the lungs and/or disseminated aspergillosis. This species is only occasionally pathogenic.

Aspergillus niger - Conidia dimensions 3.5 - 5 microns or 4 to 5 microns. Less common cause of aspergillosis. It has a musty odor. It is commonly found in the environment on textiles, in soils, grains, fruits and vegetables. It has been reported to cause skin and pulmonary infections. It is a common cause of fungal related ear infections-otomycosis.

Aspergillus sp. - Reported to be allergenic. Members of this genus are reported to cause ear infections. Many species produce mycotoxins, which may be associated with disease in humans and other animals. Toxin production is dependent on the species or a strain within a species and on the food source for the fungus. Some of these toxins have been found to be carcinogenic in animal species. Several toxins are considered potential human carcinogens. Common cause of extrinsic asthma (immediate-type hypersensitivity: type I). Acute symptoms include edema and bronchospasms; chronic cases may develop pulmonary emphysema.

Aspergillus versicolor -Conidia dimensions 2-3.5 microns. It is commonly found in soil, hay, cotton and dairy products, it can produce a mycotoxin sterigmatocystin and cyclopiaxonic acid. These toxins can cause diarrhea and upset stomach. It is reported to be a kidney and liver carcinogen. This species is only occasionally pathogenic.

Basidiomycetes - Fungal spores that are from mushrooms. The specific mushroom species cannot be identified on the culture plate. Many mushroom spores are reported to be allergenic.

Bipolaris sp. - A fungus with large spores that would be expected to be deposited in the upper respiratory tract. This fungus can produce the mycotoxin - sterigmatocystin that has been shown to produce liver and kidney damage when ingested by laboratory animals.

Blastomyces sp. - Human pathogen. The fungus is commonly found in soil. It is a dimorphic fungus, which has filamentous fungus when grown at 25 ° C, and a yeast form at 37 ° C.

Botrytis sp. - Conidia dimensions 7-14 x 5-9 microns. Found in soil and vegetables. Possibly associated with allergic symptoms (skin tests)

Chaetomium sp. - Large ascomycetous fungus producing perithecia. It is found on a variety of substrates containing cellulose including paper and plant compost. It has been found on paper in sheetrock. It is reported to be allergenic. Can produce an *Acremonium*-like state on fungal media.

Cladosporium sp. (Hormodendrum sp.) - Most commonly identified outdoor fungus. The outdoor numbers are reduced in the winter. The numbers are often high in the summer. Often found indoors in numbers less than outdoor numbers. It is a common allergen. Indoor *Cladosporium sp.* may be different than the species identified outdoors. It is commonly found on the surface of fiberglass duct liner in the interior of supply ducts. A wide variety of plants are food sources for this fungus. It is found on dead plants, woody plants, food, straw, soil, paint and textiles. It can cause mycosis. Produces greater than 10 antigens. Antigens in commercial extracts are of variable quality and may degrade within weeks of preparation. Common cause of extrinsic asthma (immediate-type hypersensitivity: type I). Acute symptoms include edema and bronchospasms; chronic cases may develop pulmonary emphysema.

Cunninghamella sp. - Can cause disseminated and pulmonary infections in immune compromised hosts.

Curvularia sp. - Reported to be allergenic. It may cause corneal infections, mycetoma and infections in immune compromised hosts.

Dreschlera sp. - Conidia dimensions 40-120 x 17-28 microns. Found on grasses, grains and decaying food. It can occasionally cause a corneal infection of the eye.

Epicoccum sp. - Conidia dimensions 15-25 microns. A common allergen, it is found in plants, soil, grains, textiles and paper products.

Fusarium sp. - A common soil fungus. It is found on a wide range of plants. It is often found in humidifiers. Several species in this genus can produce potent trichothecene toxins. The trichothecene (scirpene) toxin targets, the following systems: circulatory, alimentary, skin and nervous. Produces vomitoxin on grains during unusually damp growing conditions. Symptoms may occur either through ingestion of contaminated grains or possibly inhalation of spores. The genera can produce hemorrhagic syndrome in humans (alimentary toxic aleukia). Nausea, vomiting, diarrhea, dermatitis, and extensive internal bleeding characterize this. Reported to be allergenic. Frequently involved in eye, skin and nail infections.

Geotrichum sp. - Conidia dimensions 6-12 x 3-6 microns. A common contaminant of grains, fruits, dairy products, paper, textiles, soil and water, and often present as part of the normal human flora. The species *Geotrichum candidum* can cause a secondary infection (geotrichosis) in association with tuberculosis. This rare disease can cause lesions of the skin, bronchi, mouth, lung and intestine.

Gliocladium sp. - A fungus, which is structurally similar to *Penicillium sp.* It is reported to be allergenic.

Monilia sp. - Reported to be allergenic. This fungus produces soft rot of tree fruits. Other members produce a red bread mold. It is infrequently involved in corneal eye infections.

Mucor sp. - Often found in soil, dead plant material, horse dung, fruits and fruit juice. It is also found in leather, meat, dairy products, animal hair and jute. A *Zygomycetes* fungus that may be allergenic (skin and bronchial tests). This organism and other *Zygomycetes* will grow rapidly on most fungal media. May cause mucorosis in immune compromised individuals. The sites of infection are the lung, nasal sinus, brain, eye and skin. Infection may have multiple sites.

Paecilomyces sp. - Commonly found in soil and dust, less frequently in air. *P. variotii* can cause paecilomycosis. Linked to wood-trimmers disease and humidifier associated illnesses. They are reported to be allergenic. Some members of this genus are reported to cause pneumonia. It may produce arsine gas if growing on arsenic substrate, which can occur on wallpapers covered with Paris green.

Penicillium sp. - A wide number of organisms have been placed in this genus. Identification to species is difficult. Often found in aerosol samples. Commonly found in soil, food, cellulose and grains. It is also found in paint and compost piles. It may cause hypersensitivity pneumonitis, allergic alveolitis in susceptible individuals. It is reported to be allergenic (skin). It is commonly found in carpet, wallpaper, and in interior fiberglass duct insulation. Some species can produce mycotoxins. Common cause of extrinsic asthma (immediate-type hypersensitivity: type I). Acute symptoms include edema and bronchospasms; chronic cases may develop pulmonary emphysema.

Phoma sp. - A common indoor air allergen. It is similar to the early stages of growth of *Chaetomium sp.* The species are isolated from soil and associated plants (particularly potatoes). Produces pink and purple spots on painted walls. It may have antigens that cross-react with those of *Alternaria sp.* It will grow on butter, paint cement and rubber. It may cause phaeohyphomycosis a systematic or subcutaneous disease.

Rhizomucor sp. - The *Zygomycetous* fungus is reported to be allergenic. It may cause mucorosis in immune compromised individuals. It occupies a biological niche similar to *Mucor sp.* It is often linked to occupational allergy. May cause mucorosis in immune compromised individuals. The sites of infection are the lung, nasal sinus, brain, eye and skin. Infection may have multiple sites.

Rhizopus sp. - The *Zygomycetous* fungus is reported to be allergenic. It may cause mucorosis in immune compromised individuals. It occupies a biological niche similar to *Mucor sp.* It is often linked to occupational allergy. May cause mucorosis in immune compromised individuals. The sites of infection are the lung, nasal sinus, brain, eye and skin. Infection may have multiple sites.

Sporotrichum sp. - Reported to be allergenic. See also *Sporothrix sp.* there is some taxonomic confusion between these two genera. This genera does not cause sporotrichosis.

Stachybotrys sp. - Several strains of this fungus (*S. atra*, *S. chartarum* and *S. alternans* are synonymous) may produce a trichothecene mycotoxin- Satratoxin H - which is a poisonous by inhalation. The toxins are present on the fungal spores. This is a slow growing fungus on media. It does not compete well with other rapidly growing fungi. The dark colored fungi grows on building material with high cellulose content and low nitrogen content. Areas with relative humidities above 55% and are subject to temperature fluctuations are ideal for toxin production.

Individuals with chronic exposure to the toxin produced by this fungus reported cold and flu symptoms, sore throats, diarrhea, headaches, fatigue, dermatitis, intermittent local hair loss and generalized malaise. The toxins produced by this fungus will suppress the immune system affecting the lymphoid tissue and the bone marrow. Animals injected with the toxin from this fungus exhibited the following symptoms, necrosis and hemorrhage within the brain, thymus, spleen, intestine, lung, heart, lymph node, liver, and kidney. Affects by absorption of the toxin in the human lung are known as pneumomycosis.

This organism is rarely found in outdoor samples. It is usually difficult to find in indoor air samples unless it is physically disturbed or if there is (speculation- a drop in the relative humidity). The spores are in a gelatinous mass. Appropriate media for the growth of this organism will have high cellulose content and low nitrogen content. The spores will die readily after release. The dead spores are still allergenic and toxic. Percutaneous absorption has caused mild symptoms.

Stemphylium sp. - Reported to be allergenic. Isolated from dead plants and cellulose materials.

Trichoderma sp. - It is commonly found in soil, dead trees, pine needles, paper, and unglazed ceramics. It often will grow on other fungi. It produces antibiotics that are toxic to humans. It has been reported to be allergenic. It readily degrades cellulose.

Trichothecium sp. - Conidia dimensions 12-23 x 8-10 microns. Found in decomposing vegetation, soil, corn seeds and in flour. The species *Trichothecium roseum* can produce a trichothecene toxin that may be associated with disease in humans and other animals. Reported to be allergenic.

Ulocladium sp. - Isolated from dead plants and cellulose materials. Found on textiles.

Yeast - Various yeasts are commonly identified on air samples. Some yeasts are reported to be allergenic. They may cause problems if a person has had previous exposure and developed hypersensitivity's. Yeasts may be allergenic to susceptible individuals when present in sufficient concentrations.

(Adapted from University of Minnesota, © 12/00 AESI)