

**RESULTS OF INDOOR AIR QUALITY INVESTIGATION**

**NAVAL SEA SYSTEM COMMAND**

**WASHINGTON NAVY YARD**

**BUILDING 201**

**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 201. The initial inspection and sampling of Building 201 was conducted on September 5, 2001. Minor visible mold was discovered under the Air Handling Units.

A total of sixteen (16) 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, two (2) samples were collected for total Volatile Organic Chemicals (VOCs) in the air. 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 3,987 Counts per Cubic Meter of Air for total spores and 982 Colony Forming Units per Cubic Meter of Air (CFU / M<sup>3</sup>) of viable spores.

Air samples collected from inside Building 201 were significantly lower than the outside air. No *Stachybotrys* was found.

The samples for VOCs were collected from the building. Two (2) organic compounds were identified at low (micrograms of organic material per Cubic Meter of Air) concentrations, including 2-Propanol, and Acetone.

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. Remediation does not appear to be necessary at this time.

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 22, 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.

Outside, the weather was sunny and in the low 70's, with relative humidity at 55%. Inside, the air conditioner was on and the temperature ranged from 67 to 73 degrees with an average relative humidity of 42%. Visible mold was not observed during the visit.

A total of sixteen (16) 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 Zefon™ Air-O-Cell cassettes for total, non-viable airborne organisms.

Zefon™ 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 / M<sup>3</sup>).

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 / M<sup>3</sup>), 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, two (2) 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 addition, a TSI IAQ monitor was used to measure temperature, relative humidity, carbon monoxide (CO) and carbon dioxide (CO<sub>2</sub>). The average temperature and relative humidity has already been mentioned. The average CO level was 0 parts per million (PPM), and the range of CO<sub>2</sub> level was between 460 and 568 PPM; outside this level was 350 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<sup>3</sup>) 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<sup>3</sup>. This reference goes on to indicate that airborne contaminant indicators are 1,000 cfu/M<sup>3</sup>, 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<sup>3</sup> for total and 50 cfu/M<sup>3</sup> 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 3,987 Counts per Cubic Meter of Air for total spores – 34 % *Cladosporium*, 28 % *Amerospores*, 23 % *Ascospores*, and 5 species at 7 % or less.

Petri Dish: Viable cultures revealed 982 Colony Forming Units per Cubic Meter of Air (CFU / M<sup>3</sup>) of viable spores were incubated and identified. 80 % of this sample was *Cladosporium*, 13 % *Penicillium*, and 4 other species at 2 % each.

Air samples collected from inside were significantly lower than the outside air. The following data summarizes the findings; for complete information, please refer to the Appendices.

### **Fourth Floor (4E170)**

- Air-O-Cell: The air sample results were found to be 93 Counts per Cubic Meter of Air for total spores.
- Petri Dish: Viable cultures revealed 13 Colony Forming Units per Cubic Meter of Air (CFU / M<sup>3</sup>) of viable spores were incubated and identified - 33 % each of *Aspergillus*, *Curvularia*, and *Fusarium*.
- VOC: (Collected in the Elevator Room): The air sample revealed only two (2) different VOCs found. The chemicals found were Acetone (350 ppb) and 2-Proponol (74 ppb).

### **Fourth Floor (4E398)**

- Air-O-Cell: The air sample results were found to be 227 Counts per Cubic Meter of Air.

### **Fourth Floor (4W426)**

- Air-O-Cell: The air sample results were found to be 40 Counts per Cubic Meter of Air.

### **Third Floor (3W420)**

- Air-O-Cell: The air sample results were found to be 27 Counts per Cubic Meter of Air.
- Petri Dish: Viable cultures revealed 7 Colony Forming Units per Cubic Meter of Air (CFU / M<sup>3</sup>) of viable spores.

### **Third Floor (3W144)**

- Air-O-Cell: The air sample results were found to be 107 Counts per Cubic Meter of Air.

### **Third Floor (3E110)**

- Air-O-Cell: The air sample results were found to be 67 Counts per Cubic Meter of Air.

### **Second Floor (2E155)**

- Air-O-Cell: The air sample results were found to be 107 Counts per Cubic Meter of Air.
- Petri Dish: Viable cultures revealed 40 Colony Forming Units per Cubic Meter of Air (CFU / M<sup>3</sup>) of viable spores.

### **Second Floor (2W317/319)**

- Air-O-Cell: The air sample results were found to be 200 Counts per Cubic Meter of Air.
- VOC: (Collected in the Elevator Room): The air sample revealed only two (2) different VOCs found. The chemicals found were Acetone (170 ppb) and 2-Proponol (32ppb).

### **First Floor (1E426)**

- Air-O-Cell: The air sample results were found to be 160 Counts per Cubic Meter of Air
- Petri Dish: Viable cultures revealed 13 Colony Forming Units per Cubic Meter of Air (CFU / M<sup>3</sup>) of viable spores.

#### **First Floor (1E460)**

- Air-O-Cell: The air sample results were found to be 267 Counts per Cubic Meter of Air
- Petri Dish: Viable cultures revealed 20 Colony Forming Units per Cubic Meter of Air (CFU / M<sup>3</sup>) of viable spores.

#### **First Floor (1W080)**

- Air-O-Cell: The air sample results were found to be 53 Counts per Cubic Meter of Air

### **CONCLUSIONS**

This baseline survey revealed that, on the date of the testing, the overall air quality indoors was better than the air quality outside.

### **RECOMMENDATIONS**

Periodic monitoring should be performed to quantify changes that occur.

# Appendix A

## Sampling Locations

# Sampling Locations

Sample Number	Sample Type	Location
1	Air-O-Cell	4E170
2	Petri Dish	4E170
3	VOC	4E170
4	Air-O-Cell	4E398
5	Air-O-Cell	4W426
6	Air-O-Cell	3W420
7	Petri Dish	3W420
8	Air-O-Cell	3E110
9	Air-O-Cell	3W114
10	Air-O-Cell	2E155
11	Petri Dish	2E115
12	Air-O-Cell	2W317
13	VOC	2W319
14	Petri	1E426
15	Air-O-Cell	1E426
16	Petri Dish	1E460
17	Air-O-Cell	1E460
18	Air-O-Cell	1W080
19	Air-O-Cell	Outside
20	Petri Dish	Outside

# Appendix B

Microbiological Results

And

Lab Data



# AEROTECH LABORATORIES, INC.

Lab Number: A-109-0690  
 Project Name: NYW  
 Project Number: 0880B (201)  
 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: David Anderson

Lab Number	1			4			5					
	AOC 0936 - 4E170			AOC 0927 - 4E398			AOC 0803 - 4W426					
	0.0750			0.0750			0.0750					
Sample Identification	09/10/2001			09/10/2001			09/10/2001					
Volume (M <sup>3</sup> )	100% of Trace at 600X Magnification			100% of Trace at 600X Magnification			100% of Trace at 600X Magnification					
Date Analyzed	3			1			3					
Percent Of Trace Analyzed	Count/M <sup>3</sup>			Count/M <sup>3</sup>			Count/M <sup>3</sup>					
Debris Rating	Total Count	Result	Detection Limit	%	Total Count	Result	Detection Limit	%	Total Count	Result	Detection Limit	%
	<1	<13	13	n/a	<1	<13	13	n/a	<1	<13	13	n/a
Mycelial Fragments	<1	<13	13	n/a	<1	<13	13	n/a	<1	<13	13	n/a
Pollen Count	7	93	13	100	17	227	13	100	3	40	13	100
Total Fungal Spores	Fungal Spore Identification											
Alternaria	Fungal Spore Identification											
Amerospores	7	93	13	100	2	27	13	12	2	27	13	67
Arthrinium	Fungal Spore Identification											
Ascospores	Fungal Spore Identification											
Aspergillus/Penicillium	Fungal Spore Identification											
Aureobasidium	Fungal Spore Identification											
Basidiospores	Fungal Spore Identification											
Bipolaris/Dreschlera	Fungal Spore Identification											
Botrytis	Fungal Spore Identification											
Chaetomium	Fungal Spore Identification											
Cladosporium	Fungal Spore Identification											
Curvularia	Fungal Spore Identification											
Epicoccum	Fungal Spore Identification											
Fusarium	Fungal Spore Identification											
Nigrospora	Fungal Spore Identification											
Oidium/Peronospora	Fungal Spore Identification											
Pithomyces/Ulocladium	Fungal Spore Identification											
Rusts	Fungal Spore Identification											
Smuts/Myxomycetes	Fungal Spore Identification											
Stachybotrys	Fungal Spore Identification											
Stemphylium	Fungal Spore Identification											
Torula	Fungal Spore Identification											
Unidentified Conidia	8	107	13	47	1	13	13	33				
Notes:	Fungal Spore Identification											

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

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



# AEROTECH LABORATORIES, INC.

Lab Number: A-109-0690  
 Project Name: NYW  
 Project Number: 08808 (201)  
 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: David Anderson

Lab Number	6			8			9					
	Sample Identification	AOC 0802 - 3W/420	AOC 0941 - 3E110	AOC 930 - 3W144	Volume (M <sup>3</sup> )	0.0750	0.0750	0.0750	Date Analyzed	09/10/2001	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	Result	Detection Limit	%	Total Count	Result	Detection Limit	%	Total Count	Result	Detection Limit	%
	<1	<13	13	n/a	<1	<13	13	n/a	<1	<13	13	n/a
Pollen Count	Total Count	Result	Detection Limit	%	Total Count	Result	Detection Limit	%	Total Count	Result	Detection Limit	%
	<1	<13	13	n/a	<1	<13	13	n/a	<1	<13	13	n/a
Total Fungal Spores	Total Count	Result	Detection Limit	%	Total Count	Result	Detection Limit	%	Total Count	Result	Detection Limit	%
	2	27	13	100	5	67	13	100	8	107	13	100
Fungal Spore Identification												
Alternaria												
Amerospores	2	27	13	100	5	67	13	100	6	80	13	75
Arthrinium												
Ascospores												
Aspergillus/Penicillium												
Aureobasidium												
Basidiospores												
Bipolaris/Dreschlera												
Botrytis												
Chaetomium												
Cladosporium												
Curvularia												
Epicoccum												
Fusarium												
Nigrospora												
Oldium/Peronospora												
Pithomyces/Ulocladium												
Rusts												
Smuts/Myxomycetes												
Stachybotrys												
Stemphylium												
Torula												
Unidentified Conidia												
Notes:												

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



# AEROTECH LABORATORIES, INC.

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

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

Lab Number: A-109-0690  
 Project Name: NYW  
 Project Number: 088005 (201)  
 Date Received: 09/07/01  
 Date Reported: 09/12/01

Lab Number	10			12			15					
	Sample Identification	AOC 0100 - 2E155	AOC 0953 - 2W317	AOC 0828 - 1E426	Volume (M <sup>3</sup> )	0.0750	0.0750	0.0750	Date Analyzed	09/10/2001	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	3			3			2					
Mycelial Fragments	Total Count	Result	Detection Limit	%	Total Count	Result	Detection Limit	%	Total Count	Result	Detection Limit	%
	<1	<13	13	n/a	<1	<13	13	n/a	<1	<13	13	n/a
Pollen Count	Total Count	Result	Detection Limit	%	Total Count	Result	Detection Limit	%	Total Count	Result	Detection Limit	%
	<1	<13	13	n/a	<1	<13	13	n/a	<1	<13	13	n/a
Total Fungal Spores	Total Count	Result	Detection Limit	%	Total Count	Result	Detection Limit	%	Total Count	Result	Detection Limit	%
	8	107	13	100	15	200	13	100	12	160	13	100
Fungal Spore Identification												
Alternaria												
Amerospores	8	107	13	100	14	187	13	93	7	93	13	58
Arthrinium									1	13	13	8
Ascospores									1	13	13	8
Aspergillus/Penicillium									2	27	13	17
Aureobasidium												
Basidiospores					1	13	13	7				
Bipolaris/Dreschlera												
Botrytis												
Chaetomium												
Cladosporium									1	13	13	8
Curvularia												
Epicoccum												
Fusarium												
Nigrospora												
Oidium/Peronospora												
Pithomyces/Ulocladium												
Rusts												
Smuts/Myxomycetes												
Stachybotrys												
Stemphylium												
Torula												
Unidentified Conidia												
Notes:												

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

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



# AEROTECH LABORATORIES, INC.

Lab Number: A-109-0690  
 Project Name: NYW  
 Project Number: 0860B (201)  
 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: David Anderson

Lab Number	17			18			19			
	Sample Identification	AOC 0960 - 1E460	AOC 0832 - 1W080	AOC 0834 - Out	Volume (M <sup>3</sup> )	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	3			3			3			
Mycelial Fragments	Total Count	Count/M <sup>3</sup>		Total Count	Count/M <sup>3</sup>		Total Count	Count/M <sup>3</sup>		
		Result	Detection Limit		Result	Detection Limit		Result	Detection Limit	
Pollen Count	<1	<13	13	<1	<13	13	<1	<13	13	
Total Fungal Spores	<1	<13	13	<1	<13	13	<1	<13	13	
	20	267	13	4	53	13	299	3,987	13	
Fungal Spore Identification										
Alternaria							1	13	13	<1
Amerospores	5	67	13	3	40	13	83	1,107	13	28
Arthrinium										
Ascospores	15	200	13				69	920	13	23
Aspergillus/Penicillium							16	213	13	5
Aureobasidium										
Basidiospores							21	280	13	7
Bipolaris/Dreschlera										
Botrytis										
Chaetomium										
Cladosporium				1	13	13	103	1,373	13	34
Curvularia										
Epicoccum										
Fusarium										
Nigrospora										
Oidium/Peronospora							2	27	13	1
Pithomyces/Ulocladium										
Rusts										
Smuts/Myxomycetes										
Stachybotrys										
Stemphylium										
Torula										
Unidentified Conidia							4	53	13	1
Notes:										

Technical Review: *mt*  
 Final Review: *CS*



# AEROTECH LABORATORIES, INC.

Lab Number: A-109-0690  
 Project Name: NYW  
 Project Number: 08808 (201)  
 Date Received: 09/07/01  
 Date Reported: 09/24/01

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

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

Lab Number	2			7			11		
	Petri 4E170			Petri 3W420			Petri 2E155		
	CFU	Result	%	CFU	Result	%	CFU	Result	%
<b>Viable Fungi 20-25°C</b>	2	13	100	1	7	100	6	40	100
<i>Aspergillus fumigatus</i>									
<i>Aspergillus niger</i>									
<i>Aspergillus species Var. 1</i>									
<i>Aspergillus species Var. 2</i>									
<i>Aureobasidium</i>	1	7	50						
<i>Bipolaris</i>									
<i>Chaetomium</i>									
<i>Chysoosporium</i>									
<i>Cladosporium</i>									
<i>Cunninghamella</i>									
<i>Curvularia</i>									
<i>Epicoccum</i>									
<i>Fusarium</i>									
<i>Geotrichum</i>									
<i>Mucor</i>									
<i>Mycella sterilia</i>									
<i>Paecilomyces</i>									
<i>Penicillium species Var. 1</i>							4	27	67
<i>Penicillium species Var. 2</i>							1	7	17
<i>Phoma</i>									
<i>Rhizopus</i>									
<i>Sporothrix</i>	1	7	50				1	7	17
<i>Sporotrichum</i>									
<i>Stachybotrys</i>									
<i>Stemphylium</i>									
<i>Trichoderma</i>									
<i>Ulocladium</i>									
<i>Yeast</i>				1	7	100			

Notes: \_\_\_\_\_  
 Prepared By: AB  
 CS Review: SB  
 Technical Review: LF  
 Final Review: \_\_\_\_\_  
 A 003 Page 1 of 2



# AEROTECH LABORATORIES, INC.

Lab Number: A-109-0690  
 Project Name: NYW  
 Project Number: 0880B(201)  
 Date Received: 09/07/01  
 Date Reported: 09/24/01

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

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

Lab Number	14			16			20		
	CFU	Result	Detection Limit	CFU	Result	Detection Limit	CFU	Result	Detection Limit
Sample Identification		Petri 1E426		Petri 1E460		Petri - Out			
Date Incubated		09/07/2001		09/07/2001		09/07/2001			
Date Analyzed		09/21/2001		09/21/2001		09/21/2001			
Culture Media		Potato Dextrose (PDA)		Potato Dextrose (PDA)		Potato Dextrose (PDA)			
Volume (M <sup>3</sup> )		0.1500		0.1500		0.0560			
Viable Fungi 20-25°C									
<i>Acremonium</i>	2	13	7	3	20	7	55	982	18
<i>Alternaria</i>									
<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>Chyso sporium</i>									
<i>Cladosporium</i>				1	7	7	44	786	18
<i>Cunninghamella</i>									
<i>Curvularia</i>									
<i>Epicoccum</i>									
<i>Fusarium</i>									
<i>Geotrichum</i>									
<i>Mucor</i>									
<i>Mycella sterilia</i>									
<i>Paeclomyces</i>									
<i>Penicillium species Var. 1</i>									
<i>Penicillium species Var. 2</i>	2	13	7	2	13	7	7	125	18
<i>Phoma</i>									
<i>Rhizopus</i>									
<i>Sporothrix</i>									
<i>Sporotrichum</i>									
<i>Stachybotrys</i>									
<i>Stemphylium</i>									
<i>Trichoderma</i>									
<i>Ulocladium</i>									
<i>Yeast</i>									
Notes:									

Technical Review: LF  
 Final Review: SF



# AEROTECH LABORATORIES, INC.

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

Lab Number: A-109-0690-03  
 Project ID: NYW/0880B (201)  
 Sample ID: VOC 4E170  
 Sample Size: 400 mL Can  
 Date Received: 09/07/01  
 Date Analyzed: 09/07/01  
 Date Reported: 09/28/01

## Volatile Organic Compounds (VOC's) - Air

EPA TO14A/TO15

Results			
Compound	ppbv	µg/m <sup>3</sup>	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	<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
>200	0
10-50	0
50-200	0

Input By: *SB*  
 CS Review: *CH*

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

A010 Page 2 of 2



# 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-109-0690-13  
 Project ID: NYW/0880B (201)  
 Sample ID: VOC 2W319  
 Sample Size: 400 mL Can  
 Date Received: 09/07/01  
 Date Analyzed: 09/07/01  
 Date Reported: 10/04/01

Results			
Compound	ppbv	µg/m <sup>3</sup>	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	
1,4-Dioxane	<20	<73.2	
2,2,4-Trimethylpentane	<2.0	<9.5	
2-Butanone (MEK)	<2.0	<6	
2-Hexanone	<2.0	<8.3	
2-Propanol	32	79.8	
4-Ethyltoluene	<2.0	<8.8	
4-Methyl-2-pentanone	<4.0	<16.6	
Acetone	170	409.9	
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: SB  
 CS Review: CH

Technical Review: KH  
 Final Review: [Signature]

A010 Page 1 of 2



# AEROTECH LABORATORIES, INC.

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

Lab Number: A-109-0690-13  
 Project ID: NYW/0880B (201)  
 Sample ID: VOC 2W319  
 Sample Size: 400 mL Can  
 Date Received: 09/07/01  
 Date Analyzed: 09/07/01  
 Date Reported: 10/04/01

## Volatile Organic Compounds (VOC's) - Air

EPA TO14A/TO15

Results			
Compound	ppbv	µg/m <sup>3</sup>	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	<4.0	<14.3	
m&p-Xylene	<4.0	<17.6	
Methyl tert-butyl ether	<2.0	<7.3	
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
>200	0
Oct-50	0
50-200	0

Input By: SB  
 CS Review: CH

Technical Review: KH  
 Final Review: [Signature]

A010 Page 2 of 2



# AEROTECH LABORATORIES, INC.

Tuesday, September 11, 2001

David Anderson  
AESI  
1112 Charleston Ct.  
Keller, TX 76248

Re: Aerotech Project Number A-109-0690

Dear 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](http://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 $\mu$ ) 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.

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

A010, A010.1, B013

### **Volatile Organic Compounds (VOC's)**

Analysis for VOC's includes the EPA T015 method, utilizing a gas chromatograph (GC) coupled to a mass spectrometer (MS). This method includes quantification of 63 compounds. Tentatively identified compounds (TIC's) can also be identified and their concentrations estimated by performing a compound library search of over 100,000 compounds. Results are reported in parts per billion on a volume basis (ppbv).

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, 3<sup>rd</sup> ed., ASM, 1995.
2. Standard Methods for the Examination of Water and Wastewater, 19<sup>th</sup> 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, 7<sup>th</sup> 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

## Volatile Organic Compounds (VOC's) - Air

EPA TO14A/TO15

Lab Number: A-109-0690-03  
Project ID: NYW/0880B (201)  
Sample ID: VOC 4E170  
Sample Size: 400 mL Can  
Date Received: 09/07/01  
Date Analyzed: 09/07/01  
Date Reported: 09/28/01

Results			
Compound	ppbv	µg/m <sup>3</sup>	Comments
1,1,1-Trichloroethane	<2.0	<11.1	
1,1,1,2-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	
1,4-Dioxane	<20	<73.2	
2,2,4-Trimethylpentane	<2.0	<9.5	
2-Butanone (MEK)	<2.0	<6	
2-Hexanone	<2.0	<8.3	
2-Propanol	74	184.6	
4-Ethyltoluene	<2.0	<8.8	
4-Methyl-2-pentanone	<4.0	<16.6	
Acetone	350	843.9	
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: *JB*  
CS Review: *CH*

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

A010 Page 1 of 2

# Appendix C

## Fungal Glossary