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INDOOR AIR QUALITY SURVEY FINAL REPORT FOR:

Elizabethtown Area High School
600 East High Street in Elizabethtown, Pennsylvania 17022

Elizabethtown Area Middle School
600 East High Street in Elizabethtown, Pennsylvania 17022

East High Street Elementary School
800 East High Street in Elizabethtown, Pennsylvania 17022

Bear Creek School
1459 Sheaffer Road in Elizabethtown, Pennsylvania 17022

Bainbridge Elementary School
416 North Second Street in Bainbridge, Pennsylvania 17502

SURVEY DATE:

November 20, 2025

CALI PROJECT NUMBER: 25-1015-003

REPORT DATE: December 17, 2025

PERFORMED BY/REVIEWED BY:



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SAMPLE LOCATIONS AND SAMPLE NUMBER FOR MOLD SAMPLES:

Elizabethtown Area High School: 01: Tunnel, 02: Tunnel Upper, 03: H1605, 04: H2705, and 05: H2615

Elizabethtown Area Middle School: 06: IMC, 07: M2235, 08: M2745, 09: M1745, and 10: M0115

Elizabethtown Area High School: 11: EH502, 12: EH524, and 13: EH533

Bear Creek Elementary School: 14: BC138, 15: BC018, and 16: 063

Bainbridge Elementary School: 17: BBC116, 18: BBC137, and 19: BBC154

OUTSIDE COMPARISON SAMPLE: 20

APPENDIX "A": Mold Spore Trap Data Tables

APPENDIX "B": Mold Spore Trap Graphics Charts

APPENDIX "C": Non-Fungal Biological Particulate Data Tables

APPENDIX "D": Non-Fungal Biological Particulate Graphics Charts

INTRODUCTION INDOOR AIR QUALITY (IAQ)/RESULTS:

Cumberland Analytical Laboratories, Inc. (CALI) was retained by the Elizabethtown Area School District to perform an Indoor Air Quality (IAQ) Survey at various schools with the district. The scope of work for this survey was to conduct a general background IAQ Survey. CALI conducted a visual inspection of the school buildings and tested the following parameters:

- Carbon Monoxide (CO), Carbon Dioxide (CO₂) (ventilation), Temperature, Relative Humidity, Particulates (dust), Hydrogen Sulfide, Methane, Total Volatile Organic Compounds (VOC's); and Formaldehyde.

High CO₂ Levels were detected in:

Middle School (M2745), and M0115, and **Bear Creek** BC138.

Observations and Note:

Observations: No observations were observed at the time of the survey.

NO Total Volatile Organic Compounds (VOC's) or Formaldehyde were detected during the time of the surveys.

Health experts agree that these industrial workplace standards are not adequate for evaluating indoor air quality in standard office building environments. For this reason, the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) has suggested the use of more stringent guidelines for indoor air quality based largely on the National Ambient Air Quality (NAAQ) Standards adopted by the USEPA for outdoor air. These guidelines are based on concentrations, which at least 80% of the building occupants normally do not express dissatisfaction due to unsatisfactory indoor air quality. These guidelines do not address hypersensitive individuals with existing medical conditions.

Recent NIOSH studies indicate over 50% of indoor air quality complaints originate due to ventilation problems in the workplace. ASHRAE Standard 62-1989 recommends a ventilation supply rate of 20 CFM of outdoor air per person in office spaces for satisfactory indoor air quality. The temperature and relative humidity limits are evaluated by comparing them to the guideline standards established by ASHRAE. Specifically, the values are compared to what is considered a comfort zone correlation as described in ASHRAE Standard 55-1981, Thermal Environmental Conditions for Human Occupancy.

Definitions:

Carbon Monoxide – Inorganic compound, a highly toxic, colorless, odorless, flammable gas, chemical formula CO. It is produced when Carbon (including coal and coke) or carbon-containing fuel (including petroleum hydrocarbons, e.g., gasoline and fuel oil) does not burn completely to Carbon Dioxide, because of insufficient oxygen. CO is present in the exhaust gases of internal combustion engines and furnaces. It is toxic because it binds to hemoglobin in blood much more strongly than does oxygen and thus interferes with transport of oxygen from lungs to tissues. Symptoms of CO poisoning range from headache, nausea, and syncope to coma, weak pulse, respiratory failure, and death. CO is used industrially as a fuel and in synthesis of numerous organic compounds, including methanol, ethylene, and aldehydes. Exposure to high concentrations can be rapidly fatal.

Carbon Dioxide (CO₂) - Inorganic compound, a colorless gas with a faint, sharp odor and a sour taste when dissolved in water, chemical formula CO₂. Constituting about 0.03% of air by volume, it is produced when carbon-containing materials burn completely, and it is a product of fermentation and animal respiration. Plants use CO₂ in photosynthesis to make carbohydrates. CO₂ in earth's atmosphere keeps some of the sun's energy from radiating back into space. In water, CO₂ forms a solution of a weak acid, carbonic acid (HCO). The reaction of CO₂ and ammonia is the first step in synthesizing urea. An important industrial material, CO₂ is recovered from sources including flue gases, limekilns, and the process that prepares hydrogen for synthesis of ammonia. It is used as a refrigerant, a chemical intermediate, and an inert atmosphere; in fire extinguishers, foam rubber and plastics, carbonated beverages, and aerosol sprays; in water treatment, welding, and cloud seeding; and for promoting plant growth in greenhouses. Under pressure it becomes a liquid, the form most often used in industry. If the liquid is allowed to expand, it cools and partially freezes to the solid form, dry ice.

Temperature - A measurement of how hot or how cold a place or object is. Temperature is measured in degrees Fahrenheit or Centigrade, which is also called Celsius, using the symbol °.

Relative Humidity - Is a ratio, expressed in percent, of the amount of atmospheric moisture present relative to the amount that would be present if the air were saturated. Since the latter amount is dependent on temperature, relative humidity is a function of both moisture content and temperature. Relative Humidity is derived from the associated Temperature and Dew Point for the indicated hour.

Definitions continued:

Particulates (Dust) – Airborne particulate matter ranging in diameter from 10 to 50 microns, generated by activities such as cutting, crushing, detonation, grinding, and handling of organic and inorganic matter such as coal, grain, metal, ore, rock, wood. Their presence in upper atmosphere can cause either a net warming or a net cooling effect, depending upon their surface color. Dust particles with black upper and gray or white lower surface would cause warming, whereas those with opposite color arrangement would cause cooling. Industrial dust (generated by cutting, drilling, grinding, or sawing) can pose health risks if inhaled and (because such particles usually are less than 10 microns in diameter) would be more hazardous due to its ability to embed deep into lungs and other tissue.

Hydrogen Sulfide – Hydrogen sulfide is a flammable, colorless gas that smells like rotten eggs. People usually can smell hydrogen sulfide at low concentrations in air ranging from 0.0005 to 0.3 parts per million (ppm). Hydrogen sulfide occurs naturally in crude petroleum, natural gas, volcanic gases, and hot springs. It can also result from bacterial breakdown of organic matter. Bacteria found in your mouth and digestive tract produce hydrogen sulfide during the digestion of food containing vegetable or animal proteins. Industrial sources of hydrogen sulfide include petroleum refineries, natural gas plants, petrochemical plants, coke oven plants, food processing plants, and tanneries.

Methane - is a simple but very important covalent compound in the world of chemistry. It consists of one carbon atom bonded tightly to four hydrogen atoms. This gas can be found in natural environments, such as swamps and landfills, and is also a major component of natural gas, making it a key source of energy for heating and cooking in our homes. The study of methane helps us understand the basics of chemical bonds and how elements come together to form compounds. By exploring methane, we gain insights into both the natural processes that produce it and the human activities that release it into the atmosphere, highlighting its significance in our daily lives and the environment.

Volatile Organic Compounds (VOC's) – Volatile Organic Compounds (VOC) means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions, except those designated by EPA as having negligible photochemical reactivity.

Volatile organic compounds or VOC's are organic chemical compounds whose composition makes it possible for them to evaporate under normal indoor atmospheric conditions of temperature and pressure. This is the general definition of VOC's that is used in the scientific literature and is consistent with the definition used for indoor air quality. Since the volatility of a compound is generally higher the lower its boiling point temperature, the volatility of organic compounds is sometimes defined and classified by their boiling points.

Definitions continued:

Formaldehyde - Is a naturally-occurring organic compound with the formula CH_2O . It is the simplest of the aldehydes and is also known by its systematic name methanol. The common name of this substance comes from its similarity and relation to formic acid.

Recommended Ranges/Guidelines:

1. The recommended guideline for **carbon monoxide** is 9 ppm as an 8-hour time weighted average in an indoor environment.
2. The recommended range for **carbon dioxide** (CO_2) as a measure of ventilation is 700 ppm over ambient or 1,100 ppm. Carbon dioxide concentrations that exceed 1,100 ppm indicate there is insufficient ventilation or introduction of outdoor air into the space.
3. The recommended **temperature** range is 20°C – 26.1°C (Summer 22.7°C – 26.1°C – Winter 20°C – 24.4°C) for comfort depending on the season. Ideally the temperature should be 20°C – 21.1°C .
4. The recommended range for **relative humidity** is 30%-60% for comfort and to inhibit microbial growth and proliferation.
5. The recommended guideline for **formaldehyde** is 50 ppb in an indoor environment as a 24-hour average.
6. The recommended guideline for **particulate** is less than $50.0 \text{ ug}/\text{m}^3$ in an indoor environment as a 24-hour average.
7. The time limits for hydrogen sulfide (H_2S) exposure are as follows:

Permissible Exposure Limit (PEL): 10 parts per million (ppm) as an 8-hour time-weighted average (TWA).

Immediately Dangerous to Life or Health (IDLH): 100 ppm, where exposure could result in irreversible health effects or death.

Short-Term Exposure Limit (STEL): 15 ppm for a 15-minute period.

These limits are set to ensure worker safety and minimize health risks associated with hydrogen sulfide exposure.

Recommended Ranges/Guidelines continued:

8. **Methane:** Because methane is extremely flammable in the presence of oxygen and an ignition source (open flame pilot light) the public health threat posed from methane is the physical explosion hazard posed by methane levels between 5% and 15% by volume in the air.
9. The recommended guideline for **Volatile Organic Compounds (VOC's)** is 500 milligrams/cubic meter (mg/m³).
10. The recommended guideline for **formaldehyde** is 50 ppb in an indoor environment as a 24-hour average

Health Effects: The risk to your health from breathing in any chemical depends on how much is in the air and how long and how often you breathe it in. Not all people have the same risk. Age, gender, genetics, lifestyle, and other factors play a role in how exposure to chemicals affects health.

Carbon Monoxide Carbon monoxide poisoning can cause permanent damage to parts of your body that require a lot of oxygen, such as the heart and brain, and may result in neurological damage, illness, coma, or death. Infants, pregnant women, people with lung or heart disease, and people with anemia are especially vulnerable to the effects of carbon monoxide poisoning.

Carbon Dioxide (CO₂) At high levels, carbon dioxide itself can cause headache, dizziness, nausea and other symptoms. This could occur when exposed to levels above 5,000 ppm for many hours. Even higher levels of CO₂ can cause asphyxiation as it replaces oxygen in the blood-exposure to concentrations life and health. CO₂ poisoning, however, is very rare.

Health Effects continued:

Particulates Dust The size of particles is directly linked to their potential for causing health problems. Small particles less than 10 micrometers in diameter pose the greatest problems, because they can get deep into your lungs, and some may even get into your bloodstream.

Exposure to such particles can affect both your lungs and your heart. Numerous scientific studies have linked particle pollution exposure to a variety of problems, including:

- premature death in people with heart or lung disease
- nonfatal heart attacks
- irregular heartbeat
- aggravated asthma
- decreased lung function
- increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing.

People with heart or lung diseases, children, older adults, minority populations, and low socioeconomic status populations are the most likely to be affected by particle pollution exposure, either because they are more sensitive or may have higher exposures.

Hydrogen Sulfide is a colorless, flammable gas with a characteristic rotten egg odor. It is an important compound in the context of thiols and sulfides, as it serves as a precursor and structural component for various sulfur-containing organic molecules.

Health Effects:

Breathing very high levels of hydrogen sulfide for hours or days can cause different health impacts than breathing high levels of hydrogen sulfide for years. While you can't control all the sources of hydrogen sulfide in the environment, taking action to reduce your exposure can lower your risk of health effects now and in the future.

- Breathing low levels of hydrogen sulfide for a short time usually does not cause immediate or serious health impacts. Some people may experience eye, nose, and throat irritation.
- Breathing very high levels of hydrogen sulfide for a short amount of time can cause loss of smell. Most people can recover their sense of smell once they are away from the chemical, but some individuals may experience longer-lasting effects.

Health Effects continued:

- Breathing very high levels of hydrogen sulfide can cause nausea, vomiting, shortness of breath, loss of sleep, respiratory tract irritation, and loss of consciousness.
- At extreme levels, hydrogen sulfide can cause death.
- People with asthma, young children, older adults, and people who are sensitive to chemicals may be more likely to have health impacts from hydrogen sulfide.

Methane (CH₄), also known as marsh gas or fire damp. is an odorless, colorless, flammable gas. Methane is the main component (97%) of natural gas and one of the most abundant organic compounds on Earth. Methane, like other hydrocarbons (fossil fuels), can generate heat and energy when burned.

Most exposure to methane gas comes from people breathing trace amounts (background levels found everywhere) in the ambient (outdoor) air Exposure may also occur by breathing methane in an indoor air environment, as methane can enter indoors through very small cracks in a building's foundation.

As methane is slightly soluble (can mix with water). it can be carried by contaminated groundwater and enter homes through private water wells used for drinking and/or food preparation. When methane-contaminated groundwater comes into contact with air, the methane quickly off-gasses (turns to a vapor) and escapes into the surrounding air.

Health Effects: At very high levels methane can displace (move) the amount of oxygen in the air and can cause asphyxiation (suffocation) resulting in symptoms like headaches, dizziness, weakness nausea, vomiting, increased breathing rate, loss of coordination, loss of consciousness, and possibly death.

Because methane is extremely flammable in the presence of oxygen and an ignition source (open flame pilot light) the public health threat posed from methane is the physical explosion hazard posed by methane levels between 5% and 15% by volume in the air.

Health Effects continued:

Volatile Organic Compounds (VOC's): Health effects may include conjunctival irritation, nose and throat discomfort, headache, allergic skin reaction, dyspnea, declines in serum cholinesterase levels, nausea, emesis, epistaxis, fatigue, and dizziness.

The ability of organic chemicals to cause health effects varies greatly from those that are highly toxic, to those with no known health effects.

As with other pollutants, the extent and nature of the health effect will depend on many factors including level of exposure and length of time exposed.

Among the immediate symptoms that some people have experienced soon after exposure to some organics include eye and respiratory tract irritation, headaches, and dizziness.

Formaldehyde: Formaldehyde is a gas found in many building materials and household products. Even low levels of formaldehyde can cause irritation to the skin, eyes, nose, and throat. To reduce exposure, avoid products with formaldehyde and do not smoke indoors.

Testing Parameter / Recommended Limit of Range Table:

The following table summarizes guidelines referenced in this report. All of the guidelines referenced are recommendations and do not necessarily represent a threshold above which health symptoms will occur. Individual susceptibility varies and isolated complaints about air quality may occur even if all sampling results are within the recommended guidelines. If sampling results are all within recommended guidelines complaints about air quality should be minimal.

PARAMETER	RECOMMENDED LIMIT OF RANGE	
Temperature	Winter	20°C – 24.4°C
	Summer	22.7°C – 26.1°C
Relative Humidity	Winter	30% - 50%
	Summer	40% - 60%
Carbon Dioxide (CO ₂)	1,100 Parts Per Million (PPM) - ASHRAE	
Carbon Monoxide (CO)	9 Parts Per Million (PPM) - LEED	
Total VOC's	500 Parts per milligrams/cubic meter (mg/m ³) - LEED	
Formaldehyde	50 Parts per Billion (PPB) - LEED	
Total Particulates	50 Micrograms Per Cubic Meter - LEED	

ANALYTICAL TEST RESULTS:**Elizabethtown Area High School Testing Parameters Table:**

Room Number/Location	(CO) ppm	(CO ₂) ppm	Temperature (C°)	Humidity (%)	Particulates (ug/m ³)	Hydrogen Sulfide	Methane
Tunnel	0.00	706	20.0	20.1	64	None Detected	None Detected
Tunnel Upper	0.00	729	20.1	18.0	68	None Detected	None Detected
H1605	0.00	1010	20.7	13.2	32	None Detected	None Detected
H2705	0.00	901	20.6	9.8	54	None Detected	None Detected
H2615	0.00	1082	19.1	12.3	46	None Detected	None Detected

Elizabethtown Area Middle School Testing Parameters Table:

Room Number/Location	(CO) ppm	(CO ₂) ppm	Temperature (C°)	Humidity (%)	Particulates (ug/m ³)	Hydrogen Sulfide	Methane
IMC	0.00	823	20.3	10.8	33	None Detected	None Detected
M2335	0.00	1084	20.2	11.2	49	None Detected	None Detected
M2745	0.00	1230	20.1	13.9	32	None Detected	None Detected
M1745	0.00	942	20.1	10.6	42	None Detected	None Detected
M0115	0.00	1468	21.5	14.0	41	None Detected	None Detected

High CO₂ Levels

Total Volatile Organic Compounds (VOC's); and Formaldehyde None Detected in the High School and Middle School.

Analytical Test Results continued:**Elizabethtown Area East High School Testing Parameters Table:**

Room Number/Location	(CO) ppm	(CO ₂) ppm	Temperature (C°)	Humidity (%)	Particulates (ug/m ³)	Hydrogen Sulfide	Methane
EH502	0.00	872	18.2	15.2	34	None Detected	None Detected
EH524	0.00	1078	19.3	16.7	32	None Detected	None Detected
EH533	0.00	1088	20.1	14.0	31	None Detected	None Detected

Elizabethtown Area Bear Creek School Testing Parameters Table:

Room Number/Location	(CO) ppm	(CO ₂) ppm	Temperature (C°)	Humidity (%)	Particulates (ug/m ³)	Hydrogen Sulfide	Methane
BC138	0.00	1205	20.7	16.3	38	None Detected	None Detected
BC108	0.00	1045	21.3	13.9	32	None Detected	None Detected
BC063	0.00	938	21.1	12.0	27	None Detected	None Detected

High CO₂ Level**Elizabethtown Bainbridge Elementary Testing Parameters Table:**

Room Number/Location	(CO) ppm	(CO ₂) ppm	Temperature (C°)	Humidity (%)	Particulates (ug/m ³)	Hydrogen Sulfide	Methane
BBC116	0.00	893	20.2	16.7	39	None Detected	None Detected
BBC137	0.00	801	20.1	13.3	43	None Detected	None Detected
BBC154	0.00	1039	21.4	14.4	39	None Detected	None Detected

Total Volatile Organic Compounds (VOC's); and Formaldehyde None Detected in the East High School, Bear Creek and Bainbridge.

Recommendations:

- A. Increase the amount of fresh air in classrooms/areas,
- B. Inspect, repair, and increase air filtration,
- C. Inspect and repair supply and exhaust fans,
- D. Deploy portable High-Efficiency Particulate Air (HEPA) filters; and
- E. Ensure ventilation systems operate properly and provide acceptable indoor air quality for the current occupancy level for each room.

INTRODUCTION NON-VIABLE MOLD SPORE TRAP SAMPLING/RESULTS:

Cumberland Analytical Laboratories, Inc. (CALI) was retained by the Elizabethtown Area School District to perform **Mold Sampling** at various schools with the district. This project consisted of the collection of air samples for airborne fungal contaminants by, Mr. Richard E. Roush from this office.

- **Results:** The **Upper Tunnel** in the **High School** result was 853 *Penicillium/Aspergillus* Spore/m³ the **Outside Comparison Sample** was 267 Spore/m³.

Unusual Mold Explanations and Survey Results:

Based on the laboratory results of November 24, 2025, unusual mold conditions existed in the **Elizabethtown Area High School Upper Tunnel during the time of this survey**. The results of the Non-Viable Spore Trap Samples collected during this survey from all sampled area locations are listed in this project documentation. Please refer to the individual sample results, for more detailed information regarding these samples.

Recommendations:

Based on the Laboratory Results of **November 24, 2025**, it is recommended that to lower the total spore counts in this area, good housekeeping practices should be intensified while including the use of a bio-cide cleaning solution and HEPA vacuuming. Housekeeping is an effective measure to maintain Indoor Air Quality within a structure, as well as minimize the release of harmful materials into the structure that will negatively affect Indoor Air Quality.

Cleaning and sterilizing activities also will decrease the risk of exposure to biological growth and contamination. Also, an air scrubber containing a HEPA filter should be used during and after the cleanup for a minimum of 24-36 hours at which time the areas should be retested to ensure that airborne fungal populations have been lowered to acceptable levels.

Laboratory Disclaimer:

These samples were properly packaged and shipped to SEEML Labs Greenville, SC. While CALI considers the results of the collected and analyzed samples to be reliable through laboratory certifications and accreditations, it assumes no responsibility for the accuracy of these results and assumes no responsibility or liability for the manner in which these results are used or interpreted.

Fungal Definitions:

Alternaria Spores: Aw - 0.89. 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 these fungi will be deposited in the nose, mouth and upper respiratory tract. It may be related to bakers' asthma. It has been associated with hypersensitivity pneumonitis.

The species *Alternaria alternata* can produce tenuazonic acid and other toxic metabolites that 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.

Ascospore: A spore borne in a special cell called an ascus. Spores of this type are reported to be allergenic. All ascomycetes, members of a group of fungi called Ascomycotina, have this type of spore. The minute black dots on rotting wood and leaves or the little cups on lichens are examples of ascomycetes; another is the "truffle" mushroom.

Aspergillus/Penicillium: These are two of the most commonly found allergenic fungi in problem buildings. *Aspergillus* comes in many varieties (species). Many of the varieties produce toxic substances. It may be associated with symptoms such as sinusitis, allergic bronchopulmonary aspergillosis, and other allergic symptoms. *Penicillium* is a variety of mold that is very common indoors and is found in increased numbers in problem buildings. It also has many varieties, some of which produce toxic substances. The symptoms are allergic reactions, mucous membrane irritation, headaches, vomiting, and diarrhea. Due to the morphological similarity of *Aspergillus* and *Penicillium*, they are not differentiated by microscopic analysis and are reported together.

Aspergillus Spores: Aw 0.75 - 0.82. Reported to be allergenic. Members of this genus are reported to cause ear infections. Many species produce mycotoxins that 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; may also be associated with sinusitis, allergic bronchopulmonary aspergillosis, and other allergic symptoms.

Aureobasidium: *Aureobasidium pullulans* is a ubiquitous and generalistic black, yeast-like fungus that can be found in different environments (e.g., soil, water, air, and limestone). It is well known as a naturally occurring epiphyte or endophyte of a wide range of plant species (e.g. apple, grape, cucumber, green beans, cabbage) without causing any symptoms of disease. *A. pullulans* has a high importance in biotechnology for the production of different enzymes, siderophores and pullulans. Furthermore, *A. pullulans* is used in biological control of plant diseases, especially storage diseases.

Chronic human exposure to *A. pullulans* via humidifiers or air conditioners can lead to hypersensitivity pneumonitis (extrinsic allergic alveolitis) or "humidifier lung". This condition is characterized acutely by dyspnea, cough, fever, chest infiltrates, and acute inflammatory reactions. The condition can also be chronic, and lymphocyte mediated. The chronic condition is characterized radiographically by reticulonodular infiltrates in the lung, with apical sparing. The strains causing infections in humans were reclassified to *A. melanogenum*.

Fungal Definitions:

Basidiospore: Spore from basidiomycetes. Many varieties are reported to be allergenic.

Bipolaris Spores: Aw 0.93. Conidia dimensions: 7-14 x 5-9 microns. It is parasitic on plants and soft fruits. Found in soil and on house plants and vegetables, it is also known as "gray mold". It causes leaves to rot grapes, strawberries, lettuce, etc. It is a well-known allergen, producing asthma type symptoms in greenhouse workers and "wine grower's lung".

Botrytis Spores: A fungus with large spores that could be deposited in the upper respiratory tract. This fungus can produce the mycotoxin - sterigmatocystin, which has been shown to produce liver and kidney damage when ingested by laboratory animals.

Cercospora: Common outdoors in agricultural areas, especially during harvest. Parasite of higher plants, causing leaf spot. Commonly found as parasites on higher plants.

Chaetomium Spores: 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 can produce an *Acremonium*-like state on fungal media. Varieties are considered allergenic and have been associated with peritonitis, cutaneous lesions, and system mycosis.

Cladosporium Spores: Aw 0.88; Aw 0.84. 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 Spore* may be different than the species identified outdoors. It is commonly found on the surface of fiberglass duct liners 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. 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 skin lesions, eye ulceration, mycosis (including onychomycosis, an infection of the nails of the feet or hands) edema and bronchospasms; chronic cases may develop pulmonary emphysema.

Curvularia Spores: Reported to be allergenic and has been associated with allergic fungal sinusitis. It may cause corneal infections, mycetoma, and infections in immune compromised hosts.

Drechslera Spores: Conidia dimensions: 40-120 x 17-28 microns. Found on grass, grains and decaying food. It can occasionally cause a corneal infection of the eye.

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

Fusarium Spores: Aw 0.90. 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). This is characterized by nausea, vomiting, diarrhea, dermatitis, and extensive internal bleeding. Reported to be allergenic. Frequently involved in eye, skin, and nail infections.

Fungal Definitions continued:

Myxomycetes: Members of a group of fungi that is included in the category of "slime molds". They're occasionally found indoors, but mainly reside in forested regions on decaying logs, stumps, and dead leaves. Myxomycetes display characteristics of fungi and protozoans. In favorable (wet) conditions they exhibit motile, amoebalike cells, usually bounded only by a plasma membrane, that are variable in size and form. During dry spells, they form a resting body (sclerotium) with dry, airborne spores. These fungi are not known to produce toxins but can cause hay fever and asthma.

Memnoniella: Contaminant found most often with *Stachybotrys* on wet cellulose. Forms in chains, but it are very similar to *Stachybotrys* and sometimes is considered to be in the *Stachybotrys* family. Certain species do produce toxins very similar to the ones produced by *Stachybotrys chartarum* and many consider the IAQ importance of *Memnoniella* to be on par with *Stachybotrys*. Allergenic and infectious properties are not well studied.

Nigrospora Spores: Commonly found in warm climates, this mold may be responsible for allergic reactions such as hay fever and asthma. It is found on decaying plant material and in the soil. It is not often found indoors.

Oidium Spores: The asexual phase of *Erysiphe* Spores: It is a plant pathogen causing powdery mildews. It is very common on the leaf's stems, and flowers of plants. The health effects and allergenicity have not been studied. It does not grow on non-living surfaces such as wood or drywall.

Penicillium Spores: Aw 0.78 - 0.88. A wide number of organisms have been placed in this genus. Identification of 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. It may also cause headaches, vomiting, and diarrhea.

Periconia Spores: *Periconia* Spores: are found in soil, blackened and dead herbaceous stems leaf spots, grasses, rushes, and sedges. Almost always associated with other fungi. Rarely found growing indoors. Reportedly associated with a rare case of mycotic keratitis.

Pithomyces Spores: A common mold found on dead leaves, plants, soil and especially grass. It causes facial eczema in ruminants. It exhibits distinctive multi-celled brown conidia. It is not known to be a human allergen or pathogen. It is rarely found indoors, although it can grow on paper.

Rusts/Smuts: These fungi are associated with plant diseases. In the classification scheme of the fungi, the smuts have much in common with the rusts, and they are frequently discussed together. Both groups produce windborne, resistant teliospores that serve as the basis for their classification and their means of spread. Rust usually attack vegetative regions (i.e., leaves and stems) of plants; smuts usually are associated with reproductive structures (seeds). They can cause hay fever and asthma.

Spegazzinia: *Spegazzinia* species comprise a very small proportion of the fungal biota. This genus is somewhat related to other lobed or ornamented genera such as *Candelabrum*. No information is available regarding health effects or toxicity. Allergenicity has not been studied. Usually identified on spore trap samples where it is seen every few weeks. (Spores have very distinctive morphology.) May also be found in air by culturable (Andersen) samples if a long enough incubation period is provided so that sporulation occurs. Our laboratory has never found this organism growing on indoor environmental surfaces. Natural habitat includes soil and many kinds of trees and plants.

Fungal Definitions continued:

Sporotrichum: Sporotrichum species comprise a very small proportion of the fungal biota and are most closely related to other colorless hyphomycetes such as Chrysosporium. The only information available regarding health effects are a few rare cases of repeated isolations from respiratory secretions suggestive of bronchopulmonary colonization. No information is available regarding toxicity. Allergenicity has not been studied. May be identified on surfaces by tape lifts, tease mounts from bulk samples, and in air by culturable (Andersen) samples. Many times, sporulating colorless fungi are very difficult to identify, with critical structures only very faintly visible under oil immersion magnification. Thus, these isolations may be placed in the category "Colorless, sporulating, ID unknown" on the Andersen report format. Spores do not have distinctive morphology and would be categorized as "other colorless" on spore trap samples. Natural habitat includes soil and decaying wood.

Stachybotrys Spores: Aw - 0.94, optimum Aw >0.98. Several strains of this fungus (*S. atra*, *S. chartarum* and *S. alternans* are synonymous) may produce a trichothecene mycotoxin- Satratoxin H - which is 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 fungus grows on building material with high cellulose content and low nitrogen content. Areas with a relative humidity 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. Other symptoms include coughs, rhinitis, nosebleeds, a burning sensation in the nasal passages, throat, and lungs, and fever. 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 indoor air samples unless they are physically disturbed (or possibly -this 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 Spores: Reported to be allergenic. Isolated from dead plants and cellulose materials.

Torula Spores: Found outdoors in air, soil, on dead vegetation, wood, and grass. Also found indoors on cellulose materials. Reported to be allergenic and may cause hay fever and asthma.

Tetraploa: *Tetraploa* species comprise a very small proportion of the fungal biota. This genus is somewhat related to *Triposporium* and *Diplocradiella*. The only reported human infections are two cases of keratitis (1970, 1980) and one case of subcutaneous infection of the knee (1990). No information is available regarding other health effects or toxicity. Allergenicity has not been studied. Usually identified on spore trap samples where it is seen every few weeks. (Spores have very distinctive morphology.) Our laboratory has never found this organism growing on indoor environmental surfaces. Natural habitat includes leaf bases and stems just above the soil on many kinds of plants and trees.

Ulocladium Spores: Aw 0.89. Isolated from dead plants and cellulose materials. Found on textiles.

Zygomycetes: Zygomycetes are one of the four major groups of fungi, the others being the Oomycetes, the Ascomycetes, and the Basidiomycetes. Zygomycetes are common, fast growing, and often overgrown and/or inhibit other fungi nearby. Rhizopus and Mucor are two of the most common Zygomycetes seen in the indoor environment. However, others are seen as well, including *Syncephalastrum*, *Circinella*, *Mortierella*, *Mycotypha*, *Cunninghamella*, and *Choanephora*. For further information, please see descriptions of these individual genera.

GENERAL TERMS:

Allergen : An allergen is a substance that elicits an IgE antibody response and is responsible for producing allergic reactions. Chemicals are released when IgE on certain cells contact an allergen. These chemicals can cause injury to surrounding tissue - the visible signs of an allergy. Only a few fungal allergens have been characterized but all fungi are thought to be potentially allergenic. Fungal allergens are proteins found in either the mycelium or spores

"Black Mold": A poorly defined term. Black mold or toxic black mold has usually been associated with the mold *Stachybotrys chartarum*. While there are only a few molds that are truly black, there are many that can appear black. Not all molds that appear to be black are *Stachybotrys*.

Fungi: Fungi are neither animals nor plants and are classified in a kingdom of their own. The Kingdom of Fungi. Fungi include a very large group of organisms, including molds, yeasts, mushrooms and puffballs. There are >100,000 accepted fungal species but current estimates range to 1.5 million species. Mycologists (people who study fungi) have grouped fungi into four large groups according to their method of reproduction.

Hidden Mold: This refers to visible mold growth on building structures that is not easily seen, including the areas above drop ceilings, within a wall cavity (the space between the inner and outer structure of a wall), inside air handlers, or within the ducting of a heating/ventilation system.

Microbial Volatile Organic Compounds (MVOCs): Fungi produce chemicals as a result of their metabolism. Some of these chemicals, MVOCs, are responsible for the characteristic moldy, musty, or earthy smell of fungi, whether mushrooms or molds. Some MVOCs are considered offensive or annoying. Specific MVOCs are thought to be characteristic of wood rot and mold growth on building materials. The human nose is very sensitive to mold odors and sometimes more so than current analytical instruments.

Mold: Molds are a group of organisms that belong to the Kingdom of Fungi (see Fungi). Even though the terms mold and fungi had been commonly referred to interchangeably, all molds are fungi, but not all fungi are molds.

Mycotoxin: Mycotoxins are compounds produced by some fungi that are toxic to humans or animals. By convention, the term? Mycotoxin. Excludes mushroom toxins. Fungi that produce mycotoxins are called "toxigenic fungi."

Spore: General term for a reproductive structure in fungi, bacteria and some plants. In fungi, the spore is a structure which may be used for dissemination and may be resistant to adverse environmental conditions.

General Terms continued:

Toxic Mold: The term "toxic mold" has no scientific meaning since the mold itself is not toxic. The metabolic byproducts of some molds may be toxic (see mycotoxin).

Hypha (plural, hyphae): An individual fungal thread or filament of connected cells; the thread that represents the individual parts of the fungal body.