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INDOOR AIR QUALITY (IAQ) SURVEY REPORT:

Elizabethtown Area School
Various Schools
Elizabethtown, Pennsylvania

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Executive Summary:

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 for the following parameters:

Carbon Monoxide (CO), Carbon Dioxide (CO_2) (ventilation), Temperature, Relative Humidity, Particulates (dust), Hydrogen Sulfide, Methane, Total Volatile Organic Compounds (VOC's); and Formaldehyde.

Observations:

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

Standards:

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 dose 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 (CO_2) - Inorganic compound, a colorless gas with a faint, sharp odor and a sour taste when dissolved in water, chemical formula CO_2. 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 CO_2 in photosynthesis to make carbohydrates. CO_2 in earth's atmosphere keeps some of the sun's energy from radiating back into space. In water, CO_2 forms a solution of a weak acid, carbonic acid (HCO). The reaction of CO_2 and ammonia is the first step in synthesizing urea. An important industrial material, CO_2 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.

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.

Definitions continued:

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.

Formaldehyde - Is a naturally-occurring organic compound with the formula CH2O. 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.

Recommended Ranges/Guidelines continued:

3. The recommended **temperature** range is 20°C/F – 26.1°C/F (Summer 22.7°C/F – 26.1°C/F – Winter 20°C/F – 24.4°C/F) for comfort depending on the season. Ideally the temperature should be 20°C/F – 21.1°C/F.

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 ug/m^3 in an indoor environment as a 24-hour average.

7. The time limits for hydrogen sulfide (H2S) exposure are as follows:

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

   Immediately Dangerous to Lift 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.

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/m^3).

10. The recommended guideline for **formaldehyde** is 50 ppb in an indoor environment as a 24-hour average.

Health Effects:

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 (CO_2) 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 CO_2 can cause asphyxiation as it replaces oxygen in the blood-exposure to concentrations life and health. CO_2 poisoning, however, is very rare.

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.

Health Effects continued:

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.
- 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 (CH_4), 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 continued:

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.

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 to 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/F – 24.4°C/F
	Summer	22.7°C/F – 26.1°C/F
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	

Testing Parameters Tables:

Elizabethtown Area Middle School:

Room Number/Location	(CO) ppm	(CO_2) ppm	Temperature (C^O)	Humidity (%)	Particulates (ug/m^3)	Hydrogen Sulfide	Methane
Room 117	0.00	507	22.6	55.4	7.9	None Detected	None Detected
Room 2755	0.00	473	22.3	63.0	11.8	None Detected	None Detected
Room 2350	0.00	459	22.3	64.6	6.2	None Detected	None Detected
Room 2425	0.00	458	22.6	68.3	9.4	None Detected	None Detected

Elizabethtown Area High School:

Room Number/Location	(CO) ppm	(CO_2) ppm	Temperature (C^O)	Humidity (%)	Particulates (ug/m^3)	Hydrogen Sulfide	Methane
Room 1645	0.00	451	22.5	66.7	10.2	None Detected	None Detected
Room 1210	0.00	468	22.2	64.0	4.2	None Detected	None Detected
Room 1305	0.00	468	22.3	64.4	4.4	None Detected	None Detected
Room 2735	0.00	486	22.4	67.2	5.8	None Detected	None Detected

Testing Parameters Tables continued:

East High Elementary School:

Room Number/Location	(CO) ppm	(CO_2) ppm	Temperature (F^O)	Humidity (%)	Particulates (ug/m^3)	Hydrogen Sulfide	Methane
Room 510	0.00	495	24.2	63.9	6.7	None Detected	None Detected
Room 500	0.00	500	74.8	66.0	7.8	None Detected	None Detected
Room 540	0.00	532	75.2	64.7	7.9	None Detected	None Detected

Bear Creek Intermediate:

Room Number/Location	(CO) ppm	(CO_2) ppm	Temperature (F^O)	Humidity (%)	Particulates (ug/m^3)	Hydrogen Sulfide	Methane
Room 147	0.00	516	69.0	48.8	4.6	None Detected	None Detected
Room 018	0.00	470	69.6	53.2	3.2	None Detected	None Detected
Room 058	0.00	479	69.0	57.7	4.2	None Detected	None Detected

Bainbridge Elementary:

Room Number/Location	(CO) ppm	(CO_2) ppm	Temperature (F^O)	Humidity (%)	Particulates (ug/m^3)	Hydrogen Sulfide	Methane
Room C107	0.00	430	72.0	53.6	14.8	None Detected	None Detected
Room C131	0.00	443	72.1	59.4	16.8	None Detected	None Detected
Room C154	0.00	435	70.7	61.6	14.9	None Detected	None Detected

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

Recommendations:

Based on the survey results of August 27, 2026, no recommendations are warranted at this time.