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SUGGESTED EXPOSURE CLASSIFICATION GUIDELINES FOR INDOOR AIRBORNE MOLD AND DUST

March 2021



**AIR****PROFILE™**

March 2021

INDOOR AIRBORNE MOLD AND DUST - SUGGESTED EXPOSURE CLASSIFICATION GUIDELINES

Air Sample Database - 2017 and 2018

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OVERVIEW

This document provides suggested data interpretation guidelines based on a statistical analysis of over 3,500 indoor and 1,000 outdoor airborne samples collected for the analysis of airborne bioaerosols and dust. These samples were collected by our industrial hygiene clients as a part of over 1,200 commercial and residential indoor air quality inspections during 2017 and 2018. The samples were collected using the Air-O-Cell® slit-impaction sampler and analyzed by Optical Microscopy using a combination of bright field and polarized light microscopy.

The descriptive comments in the analysis reports and the data summary tables incorporate a unique color-coded **AIR PROFILE™** statistical exposure classification system based upon our nationwide database. This classification system conforms with industry accepted statistical analysis methods and provides a simple and concise way to compare indoor airborne levels of common aerosols and bioaerosols found inside a building, with data collected from other buildings located throughout the country. The descriptive ranges cannot be directly used to infer safe or unsafe levels, and the final interpretation of air sampling data should be performed by a qualified environmental professional in conjunction with a thorough visual inspection.

In order to reduce the inherent bias from potential *problem* buildings in the database, the following selection criteria were used. First, samples analyzed from non-occupied buildings, or buildings with known building-wide damage from flooding, mold growth, or demolition / renovation activities were not included in the database. Second, the measured 99th percentile of the remaining mold data was used as an upper threshold to remove any additional potential *problem* moldy buildings from the database. Buildings containing more than one indoor sample with total mold spore concentrations measured above this 99th percentile (calculated at ~40,000cts/m³) were also removed. Following this procedure, estimates of the number of *problem*, *non-problem*, and *not determined* building conditions remaining in the database were estimated according to criteria defined at the bottom of page 9. Although indoor and outdoor sampling data was compiled and statistically analyzed on a monthly basis, the comparative exposure ranges used in the **AIR PROFILE™** system are based on the indoor airborne exposure data only. The outdoor sampling data is useful as a comparison tool to assess the potential impact from the seasonal outdoor infiltration.

A non-parametric analysis approach was used because the distribution of airborne aerosols in our database were found to more closely approximate a lognormal distribution, were not consistently predictable, and contained a significant number of left censored measurements (e.g. a significant number of measurements below the detection limit). As a result, using the percentile frequency of baseline data is a better estimator of central tendency (e.g. geometric mean or 50th percentile), and also a more reliable representation of the distribution and concentration range of the airborne exposure measurements in general. The percentile comparison ranges used in our laboratory reports are described in more detail on pages 3-5 of this document. The database consists primarily of Northeast, Upper Midwest, and West Coast buildings. Approximately 10-20 buildings from the Southeast United States are included in the database. These buildings are grouped together with the Upper Midwest and Northeast regional data due to the typically higher vegetation, humidity, and airborne mold spore concentrations than measured in dryer West Coast climatic zones. The color-coded **AIR PROFILE™** percentile guidelines are designed to be used as a preliminary background comparison in the absence of government accepted exposure guidelines or any published permissible exposure limits (PEL's) for mold spores, pollen, irritant, or other building generated dust particles. When used in combination with our *Method Interpretation Guide* (see our website at eaalab.com) the exposure classification system can provide valuable diagnostic insight into the location of potential indoor dust sources and their impact on indoor air quality.

The combined nationwide data for both commercial and residential buildings is used as the default database for the exposure guidelines provided in our laboratory reports. Using this data set is a good general compromise because approximately 70% of samples in the database are from commercial buildings where the mold and other dust particle concentrations are typically lower than found in residential buildings (see the color-coded tables given on page 14). When airborne mold samples are collected from desert communities or very dry climatic locations where there is very low vegetation, the investigator may also want to consider using the West Coast percentile frequency of occurrence guidelines shown near the bottom of page 9 as an initial comparison.

IMPORTANT CAUTION : Providing hazard communication or recommendations for remedial action should always first be based on a thorough visual inspection and the professional judgement of a trained environmental professional. The suggested terminology and data evaluation criteria suggested below only addresses the statistical comparison of individual samples with the airborne percentile concentration ranges measured within our database of occupied buildings. It does not take into account the critical observational data required to render an accurate and complete exposure assessment for any specific building. The percentile ranges cannot be used as the sole criteria to infer a *safe*, *unsafe*, or *elevated* condition is present. Although the guidelines and analytical data provide diagnostic information, and can alert the investigator to potential mold or dust sources that are not readily observable, the results should always be used as secondary information to help support a thorough visual inspection. Laboratory results should never be used as the sole basis to provide remedial guidance or define a health exposure risk.

Since industry accepted threshold levels or permissible exposure limits (PEL's) are not available for mold and most other types of common dust particles, the terminology typically used for exposure assessment, e.g. *acceptable*, *uncertain*, and *unacceptable*, are not directly applicable. Although our past use of exposure classifications of *Low*, *Moderate*, and *High* were clearly defined by statistical parameters, recent feedback from exposure assessment professionals has encouraged us to clarify and redefine our terminology that describes the percentile classifications. These changes should help better define the appropriate interpretation of sample results guidelines. Environmental Analysis (EAA) now uses the terminology of *Typical*, *Atypical*, and *Elevated* to describe the statistical ranges. The classifications are divided into six ranges (representing the <50th, >50th, >75th, >90th, >95th, and >99th percentiles). These percentile ranges are industry accepted metrics commonly used to classify and compare data sets collected in one building with background or control levels collected from other buildings.

The descriptive categories have two levels for each percentile concentration ranking and are defined below:

- Typical** - Measured background concentrations are consistent with the 50th percentile frequency of occurrence up to and including the 75th percentile.
- Atypical** - Measured concentrations consistent with the percentile frequency of occurrence exceeding the 75th percentile, but less than the 95th percentile.
The lower range of the Atypical category is usually 2-3 times higher than the 50th percentile.
- Elevated** - Measured concentrations with the percentile frequency of occurrence ranges exceeding the 95th percentile.
The lower range of the Elevated category is usually 10 times higher or greater than the 50th percentile.

The six percentile category levels and color-coding used to define the exposure ranges used by EAA are given below:

Classification	Level	Percentile	Description (Statistical)
Elevated	6	>99 th	The upper 1% of all buildings consistent with a generating dust source present
Elevated	5	95 th - 99 th	The upper 5% of all buildings consistent with a generating dust source likely present
Atypical	4	90 th - 95 th	The upper 10% of all buildings where amplification or elevated levels may be indicated
Atypical	3	75 th - 90 th	The upper 25% of all buildings (average to slightly above average)
Typical	2	50 th - 75 th	The average background found in up to 75% of buildings
Typical	1	<50 th	The lower 50% of concentration measurements in all buildings

The 75th percentile (Level 3 of the nationwide database) is used as an upper background threshold where the concentrations are likely normal or typical and where no significant impact or action is indicated. The 75th percentile of airborne dust measurements is usually a close approximation of the arithmetic average. Multiple measurements in the range between the 75th and 90th percentile, i.e. defined by EAA as Level 3, may warrant further investigation. The 90th percentile, defined by EAA as Level 4, is commonly used as an industry exposure metric to define where an atypical concentration or impact may be present. An investigator might consider using measured concentrations above the 90th percentile as warranting further investigation and/or additional actions if multiple sample measurements are found in this same range. (This doesn't necessarily mean there is a health impact above the 90th, 95th, or 99th percentiles, it simply classifies the measured dust concentrations as compared to other buildings). Levels measured above the 95th percentile, i.e. Level 5, or the 99th percentile Level 6, might warrant appropriate hazard communication and the implementation of exposure control measures for some analytes such as mold, fiberglass, or other potential irritant particles. Implementation of additional cleaning and/or remediation measures based upon successfully locating the emission source and onsite conditions might also be considered. For other common particle categories such as skin cell fragments or mineral dust, it may simply indicate that more frequent or thorough cleaning should be recommended. Decisions regarding remedial action should not be based on the air sampling data or the EAA suggested guidelines alone.



The classifications for common indoor particles analyzed in the **AIR PROFILE™** report are based on a combination of their origin, morphology, optical properties, and potential building condition they may represent (see the *Airborne and Surface Dust Interpretation Guide* located on our website at eaalab.com). Example micrographs of particles representative of each classification and the Optical and Electron Microscopy imaging techniques used are shown below:

PARTICLE CLASSIFICATIONS									
Mold Spores	Algal / Fern Spores	Insect Parts	Pollen	Skin Cell Fragments	Fiberglass Fibers	Cellulose / Synthetic Fibers	Optically Opaque Particles	Crystalline Mineral Particles	Fire Residue Particles
BF	BF	BF	BF	BF	BF	BF	BF	BF	RLDF
SEM	BF	BF	SEM	BF	SEM	PLM	BF	PLM	SEM

BF = Bright Field Optical Microscopy, RLDF = Reflected Light Dark Field Optical Microscopy, PLM = Polarized Light Microscopy, SEM = Scanning Electron Microscopy

The following **AIR PROFILE™** classifications, exposure ranges, and possible response actions are to be used in conjunction with the visual inspection observations:

Classification	Level	Percentile	Condition / Potential Response Actions
Elevated	6	>99 th	Significantly elevated - Further investigation warranted
Elevated	5	95 th - 99 th	Elevated - Further investigation likely warranted
Atypical	4	90 th - 95 th	Atypical - Further investigation may be warranted (If levels found in multiple samples)
Atypical	3	75 th - 90 th	Atypical - Further investigation may be warranted (If levels found in multiple samples)
Typical	2	50 th - 75 th	Typical background / acceptable - No action indicated
Typical	1	<50 th	Below the average or typical background - No action indicated

The **AIR PROFILE™** measured airborne concentration ranges associated with each classification are summarized below:

INDOOR AIRBORNE CLASSIFICATION GUIDELINES															
Approximate Percentile Concentration Thresholds (Cts/m³) - Based on the EAA nationwide database															
		Chronic							Skin		Cellulose			*** Fire Residue	
Classification	Percentile	Total Mold	Asp / Pen	* W.I. Mold	Outdoor Mold	Algal Fern	Insect Parts	Pollen	Cell Frag.	Fiber-glass	**/ Syn Fibers	Opaque Dust	Mineral Dust		
Elevated - 6	>99 th	>40000	>22000	>240	>16000	>950	>1000	>40	>30000	>650	>5900	>41000	>132000	10x bkg.→	N/A
Elevated - 5	>95 th	>12000	>3500	>100	>8000	>500	>500	>13	>15000	>90	>1800	>13000	>41000		>1000
Atypical - 4	>90 th	>6000	>1000	>50	>5000	>240	>180	>7	>10000	>30	>1100	>7800	>22000	3x bkg.→	N/A
Atypical - 3	>75 th	>1600	>140	>20	>1500	>140	>60	>7	>6000	>8	>600	>3700	>9000		>300
Typical - 2	>50 th	>400	>18	>11	>360	>90	>60	>3	>3050	>4	>290	>1800	>4400	bkg. → (2x d.l.)	>100
Typical - 1	<50 th	<400	<18	<11	<360	<90	<60	<3	<3050	<4	<290	<1800	<4400		<100

Note: The calculated data shown on page 9 has been rounded "up" to 3 decimal places to define each exposure classification range

* W.I. = Water indicating, ** Syn = Synthetic

*** Preliminary fire particle data is in a separate database of non-fire complaint related buildings. Because of the high percentage of measurements found below the limit of detection (~40%), the comparison guidelines are based on the differential above a value of twice the method detection limit (d.l.).

Atypical and Elevated classifications are defined as 3 and 10 times the background (bkg) respectively.

d.l. = 50cts/m³



The following tables and graphs summarize the 2017/2018 database findings, and are the basis for the color-coded **AIR PROFILE**™ exposure ranking system. Although the guidelines are a useful tool to compare dust related complaints with measured airborne concentrations, it is important to emphasize the airborne dust profile analysis by itself may not directly address medical or comfort complaints that are associated with other factors such as temperature, humidity, or the presence of hazardous materials, volatile organic compounds, or odors. Our analytical tests provide only one piece of what should be a comprehensive IAQ investigation. The goal of our analysis report and the **AIR PROFILE**™ exposure ranking system is to identify potential dust sources that may be associated with reported symptoms. A complaint building or actual problem building are often not one and the same and cannot be accurately differentiated. As often as not, an air quality complaint may not be supported by, or associated with the actual airborne measurements in the context of being different than the dust profile found in any other similar building. Based on our 30 years of experience performing both field investigations and laboratory analysis, individual irritant, allergy, lung-related complaints, or other symptoms can sometimes be traced directly to elevated mold, dust, or potential irritant particle exposures such as fiberglass. This is especially true for susceptible individuals with certain medical or allergy conditions. Other common indicator particles such as skin cell fragment concentrations are not necessarily a health-related indicator as much as they are an indication of high occupant density, and/or the efficacy of cleaning practices performed in the building. The dust categories used by EAA are discussed more thoroughly and illustrated in the *Airborne and Surface Dust Interpretation Guide* (see our website at eaalab.com).

The percentile frequency of occurrence of measured concentrations, is commonly used by the ACGIH, US EPA, OSHA, and exposure researchers as a metric to differentiate *problem* from *non-problem* environments for a wide range of bioaerosol, nutrient, and analytical testing data. This is especially true when the data is left censored (i.e. a significant portion of the measurements are below the detection limit) as in the case of exposure to mold, pollen, and fiberglass. This metric is also routinely used to establish action levels. The percentile frequency of occurrence analyzes a range of collected values and determines the value at which a certain percentage of measurements are above and below this value. For example, the 50th percentile is the value at which 50% of the measurements are both above and below that value. The 90th percentile is the value at which 10% of the measurements are above that value and 90% are below the value. The EAA Summary Report suggests using the 75th and 90th percentiles as key exposure metrics to initially classify whether or not a measurement is *Atypical / Non-problem* as defined by the 75th percentile; or *Atypical or a potential problem* measurement as defined by the 90th percentile. The 90th and 95th percentiles are often used as threshold action levels. In this way a *complaint* building can be systematically differentiated from a potential *problem* building based on a combination of its airborne dust profile and observations gathered during a thorough visual inspection. The scientific rationale and support for using these percentile metrics is described below.

There is a large body of research supporting the use of the 75th and 90th percentiles as an analytical metric for both differentiating potential problem from non-problem environments, and developing suggested action levels. As stated above, the site inspection and professional judgement are the primary criteria used to arrive at conclusions and provide recommendations. The laboratory data should be used as secondary information to help support any findings. In cases such as pesticide exposure, where the data is expected to be lognormally distributed, and the exposure is considered leading to chronic effects (EUROPOEN, a Predictive Occupational Exposure Database for Registration Purposes of Pesticides⁵), the 75th percentile is suggested as a way to differentiate *problem* and *non-problem* conditions in large data sets (i.e. 50-100 data points). The data collected in IAQ investigations are more likely comprised of much smaller data sets. The arithmetic means for the EAA inorganic particle and non-mold data most closely approximates the 75th percentile. The measured arithmetic mean for the EAA mold spore data more closely approximates the 90th percentile. The 90th percentile is often used as a more conservative problem indicator for small data sets (15-20 or less) as suggested by both the ACGIH¹ and EUROPOEN⁶ example references.

1. 1999 ACGIH. *Bioaerosols: Assessment and Control*, Chapter 14.2.3.1. *Quantitative Database Comparisons*.
2. November 30, 2012. U.S. EPA Proposed Rule for Numeric Nutrient Criteria, "Technical Support Document for U.S. EPA's Proposed Rule for Numeric Nutrient Criteria for Florida's Estuaries, Coastal Waters, and South Florida Inland Flowing Waters, Volume 2, Coastal Waters, page 26, paragraph 1.
3. Section 40CFR §141.80 of US Code of Federal Regulations, *National primary drinking water regulations, (c) Lead and copper action levels (using the 90th percentile)*.
4. 1999-2001. *The US EPA Air Data Air Quality Index Reports using the 90th percentile for the monitoring of PM₁₀ and PM_{2.5} as a metric of decreasing air quality*.
5. 2006. *A Strategy for Assessing and Managing Occupational Exposures*. AIHA Publications, 3rd edition.
6. February 2001. *Applied Occupation Hygiene*. 16(2):246-50. EUROPOEN, a Predictive Occupational Exposure Database for Registration Purposes of Pesticides, Abstract.
7. January 2000. U.S. Department of Energy. *Improved Methods for Calculating Concentrations Used in Exposure Assessments*.



AIR PROFILE™ COMBINED NATIONWIDE STATISTICAL DATABASE SUMMARY (2017-2018)

Indoor & Outdoor Airborne Mold Spore and Dust Concentrations (Cts/m³)

ALL NATIONWIDE DATA (MVEC/WC) - ARITHMETIC AVERAGE MOLD LEVELS (MONTHLY)

Total Mold Samples	4,904	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average	CV
# of Indoor Samples	333	256	351	346	345	339	272	377	476	267	304	179		320	0.23
# of Outdoor Samples	68	64	100	78	101	106	92	121	111	97	80	41		88	0.26
* Total - Inside	1449	2590	910	1124	1326	2457	3867	4637	4406	5400	1628	2625		2702	0.57
Median (50 th Percentile)	226	226	183	169	283	226	452	686	1420	1230	339	226		472	0.90
Total - Outside	1687	15111	2038	5018	8393	10778	12521	25584	30782	24376	10615	6946		12821	0.74
Median (50 th Percentile)	666	824	688	1325	3450	6185	7510	18400	25700	9090	2255	903		6416	1.25
* Asp / Pen - Inside	850	1441	598	591	373	1156	2500	1783	1618	740	420	1451		1127	0.58
Median (50 th Percentile)	18	18	18	18	18	18	18	57	18	58	18	18		25	0.63
Asp / Pen - Outside	104	100	161	190	108	112	277	617	439	523	282	200		259	0.68
Median (50 th Percentile)	18	18	18	18	18	18	57	283	169	137	18	18		66	1.30
** Water-Indicating-Inside	10	16	4	21	9	10	6	14	4	27	5	11		11	0.64
Water-Indicating-Outside	4	2	1	1	2	1	3	3	2	2	2	1		2	0.46
Hyphal Fragments-Inside	33	32	46	37	32	40	60	53	37	57	28	30		40	0.27
Hyphal Fragments-Outside	13	18	40	100	28	41	45	75	46	87	72	21		49	0.58

ALL NATIONWIDE DATA (MVEC / WC) - ARITHMETIC AVERAGE DUST LEVELS (MONTHLY)

Total Dust Samples	2,628	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average	C.V.
# of Indoor Samples	219	158	174	222	211	217	155	216	225	108	163	106	181	0.24	
# of Outdoor Samples	27	30	31	29	58	52	54	54	36	32	34	17	38	0.35	
Pollen grains - Inside	2	2	4	6	5	11	3	3	3	4	3	3	4	0.63	
Pollen grains - Outside	7	35	190	50	179	146	13	18	18	10	3	3	56	1.29	
Skin Cells - Inside	3925	3783	4172	4252	4255	4943	4138	4784	4564	9216	5009	4649	4808	0.30	
Skin Cells - Outside	1969	620	960	525	1177	686	939	1355	724	1055	698	697	950	0.43	
Fiberglass - Inside	44	46	31	7	35	29	24	67	6	47	31	21	32	0.54	
Fiberglass - Outside	3	3	18	3	7	5	5	11	17	5	3	21	8	0.80	
Cellulose/Syn fibers - Inside	520	702	704	584	427	593	517	621	393	984	749	398	599	0.28	
ellulose/Syn fibers - Outside	217	192	210	155	166	197	200	160	112	140	122	111	165	0.23	
Opaque Dust - Inside	7236	3345	2910	3586	2886	2586	4334	4420	3213	9140	5241	5409	4525	0.44	
Opaque Dust - Outside	9242	12631	12380	8233	5823	6281	6373	6667	8993	12054	9827	16988	9624	0.35	
Mineral Dust - Inside	6532	7189	9174	8233	10326	7976	9676	9419	9086	31770	19952	15544	12073	0.60	
Mineral Dust - Outside	9128	7540	17278	15900	10447	10611	11866	9949	26579	16913	11590	33116	15076	0.51	

REGION			Total #		SAMPLE DISTRIBUTION					Commercial	
Building Type	* WC	*MWEC	Buildings Inspected		Mold	Ratio%	Dust	Ratio%		Building Type	Total
Residential	161	407	568		1128	29%	181	8%		Schools	129
***Commercial	181	501	648	682	2714	71%	1993	92%		Hospital / Medical	115
			Indoor	Outdoor only					Office	363	
* WC=West Coast, MWEC=Midwest/East Coast (Primarily Northeast)											
							Other (labs, stores, etc.)				41

* WC=West Coast, MVEC=Midwest/East Coast (Primarily Northeast)

* The monthly "arithmetic mean" values for indoor "Total" and "Aspergillus/Penicillium" spores are positively skewed by isolated high measurements associated with some suspect problem buildings.

** Water-Indicating fungi (Chaetomium, Stachybotrys, and Ulocladium) are often associated indoors with chronic moisture.

*** Commercial / office buildings include all buildings that are not single family residences

Note: Because indoor mold spore concentrations tend to be exponentially or lognormally distributed (especially when indoor growth is present), statistical database comparisons using limited data should be compared by using the median (i.e. 50th percentile) and other "percentile frequency of occurrence" ranges. The AIR PROFILE™ exposure ranking system for mold spores and other dust categories is based on using the 50th, 75th, 90th, 95th, and 99th percentiles to establish six (6) color-coded classification categories (Level 1 - 6 respectively).



AIR PROFILE™ EAST COAST / MIDWEST STATISTICAL DATABASE SUMMARY (2017-2018)

Indoor & Outdoor Airborne Mold Spore and Dust Concentrations (Cts/m³)

EAST COAST/MIDWEST DATA (MVEC) - ARITHMETIC AVERAGE MOLD LEVELS (MONTHLY)

Total Mold Samples	3,606	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average	CV
# of Indoor Samples	279	189	266	238	224	246	206	311	399	189	225	132	242	0.28	
# of Outdoor Samples	38	35	62	53	59	68	64	88	87	62	60	26	59	0.32	
* Total - Inside	1619	3202	958	1426	1192	2589	4601	4847	4945	5824	2046	3069	3027	0.55	
Median (50thPercentile)	226	226	183	226	283	226	678	848	1550	1280	452	183	530	0.88	
Total - Outside	860	19132	1201	5087	11148	15389	16824	32907	36599	29411	11598	2758	15243	0.81	
Median (50thPercentile)	396	736	278	848	5250	12150	12650	26900	29000	13100	2400	311	8668	1.19	
* Asp / Pen - Inside	970	1799	672	779	404	1061	2934	1698	1909	717	551	1857	1279	0.59	
Median (50thPercentile)	18	18	18	18	18	18	18	57	18	46	18	18	24	0.56	
Asp / Pen - Outside	58	47	65	112	75	115	273	687	352	613	285	53	228	0.98	
Median (50thPercentile)	18	18	18	18	18	18	18	366	169	137	18	18	70	1.54	
* Water-Indicating-Inside	9	22	4	31	14	12	7	9	5	38	7	16	15	0.74	
Water-Indicating-Outside	2	2	2	2	2	2	3	4	2	2	2	2	2	0.29	
Hyphal Fragments-Inside	34	33	30	43	24	44	71	50	32	50	31	32	0	0.00	
Hyphal Fragments-Outside	12	16	15	129	21	43	40	67	39	102	88	22	0	0.00	

EAST COAST/MIDWEST DATA (MVEC) - ARITHMETIC AVERAGE DUST LEVELS (MONTHLY)

Total Dust Samples	1,751	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average	CV
# of Indoor Samples	195	115	122	136	120	161	93	165	165	62	94	68		125	0.33
# of Outdoor Samples	20	15	15	15	29	31	32	32	23	15	20	8		21	0.38
Pollen grains - Inside	2	2	3	4	5	14	3	2	2	3	2	3		4	0.89
Pollen grains - Outside	2	10	3	50	333	223	7	30	17	3	3	2		57	1.88
Skin Cells - Inside	3474	2060	3993	3243	2899	5306	3744	4537	3771	6486	3326	3076		3826	0.31
Skin Cells - Outside	1492	216	980	485	1124	734	977	1208	563	652	516	235		765	0.52
Fiberglass - Inside	49	10	22	8	23	37	7	69	7	15	31	30		26	0.74
Fiberglass - Outside	3	3	4	3	5	4	4	10	18	3	3	38		8	1.29
Cellulose/Syn fibers - Inside	456	327	648	346	285	606	483	445	334	456	725	309		452	0.32
ellulose/Syn fibers - Outside	138	92	165	185	140	133	182	167	88	75	85	65		126	0.34
Opaque Dust - Inside	7681	2672	1836	3309	1518	2695	2676	3946	2879	2382	3887	6023		3459	0.51
Opaque Dust - Outside	6136	7829	5733	5555	3434	5178	4594	4763	8918	4622	5927	18077		6731	0.57
Mineral Dust - Inside	6525	6076	7132	5555	6654	9141	7744	8361	5259	17333	18881	21261		9993	0.57
Mineral Dust - Outside	12330	14386	11740	11589	9877	15571	11777	11061	43524	10699	15440	62940		19245	0.86

REGION Total #			Commercial	
Building Type	*MVEC	Buildings Inspected	Building Type	Total
Residential	407	407	Schools	123
***Commercial	501	501 463	Hospital / Medical	64
		Indoor Outdoor only	Office	243
* MVEC = Midwest/East Coast (Primarily Northeast)			Other (labs, stores, etc.)	33

* The monthly "arithmetic mean" values for indoor "Total" and "Aspergillus/Penicillium" spores are positively skewed by isolated high measurements associated with some suspect problem buildings.

** Water-Indicating fungi (Chaetomium, Stachybotrys, and Ulocladium) are often associated indoors with chronic moisture.

*** Commercial / office buildings include all buildings that are not single family residences

Note: Because indoor mold spore concentrations tend to be exponentially or lognormally distributed (especially when indoor growth is present), statistical database comparisons using limited data should be compared by using the median (i.e. 50th percentile) and other "percentile frequency of occurrence" ranges. The AIR PROFILE™ exposure ranking system for mold spores and other dust categories is based on using the 50th, 75th, 90th, 95th, and 99th percentiles to establish six (6) color-coded classification categories (Level 1 - 6 respectively).



AIR PROFILE™ WEST COAST DATA STATISTICAL DATABASE SUMMARY (2017-2018)

Indoor & Outdoor Airborne Mold Spore and Dust Concentrations (Cts/m³)

WEST COAST DATA (WC) - ARITHMETIC AVERAGE MOLD LEVELS (MONTHLY)

Total Mold Samples	1,303	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average	CV
# of Indoor Samples	54	67	87	108	121	93	66	66	77	78	79	47	79	0.27	
# of Outdoor Samples	30	29	39	25	42	40	28	33	24	35	20	15	30	0.28	
* TOTAL - Inside	571	863	889	459	1573	2109	1575	3645	1617	4373	437	1377	1624	0.76	
Median (50 th Percentile)	175	170	183	101	183	113	179	201	689	1220	85	457	313	1.07	
TOTAL - Outside	2735	7115	3703	4874	4524	2830	2684	6058	9696	15456	7666	14205	6796	0.64	
Median (50 th Percentile)	1155	1140	2500	2450	1975	1230	2280	1450	3565	2880	1895	5400	2327	0.52	
* Asp / Pen - Inside	225	421	462	175	317	1405	1110	2180	107	796	42	318	630	1.02	
Median (50 th Percentile)	17	17	17	17	17	17	17	17	17	116	17	17	25	1.13	
Asp / Pen - Outside	162	160	311	354	153	110	287	424	752	358	274	455	317	0.56	
Median (50 th Percentile)	58	17	17	46	17	17	117	116	316	138	46	17	77	1.14	
** Water-Indicating-Inside	20	1	6	1	1	7	5	43	2	3	1	1	8	1.62	
Water-Indicating-Outside	7	4	1	1	3	1	6	1	3	3	3	1	3	0.68	
Hyphal Fragments-Inside	27	29	95	24	46	30	27	69	65	76	20	26	45	0.56	
Hyphal Fragments-Outside	14	20	80	39	39	45	59	96	73	59	25	20	47	0.55	

WEST COAST DATA (WC) - ARITHMETIC AVERAGE DUST LEVELS (MONTHLY)

Total Dust Samples	877	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average	CV
# of Indoor Samples	24	43	52	86	91	56	62	51	60	46	69	38	57	0.34	
# of Outdoor Samples	7	15	16	14	29	21	22	22	13	17	14	9	17	0.37	
Pollen grains - Inside	3	4	6	11	6	4	4	5	5	5	4	3	5	0.38	
Pollen grains - Outside	22	60	378	50	51	32	21	6	20	16	4	4	55	1.87	
Skin Cells - Inside	7587	8112	4565	5778	6005	3900	4731	5520	6692	13015	7325	7215	6704	0.36	
Skin Cells - Outside	3332	997	941	568	1228	686	884	1562	1009	1432	958	1109	1226	0.59	
Fiberglass - Inside	7	143	52	5	50	8	49	64	4	91	33	7	43	0.99	
Fiberglass - Outside	3	3	31	3	10	5	7	11	16	6	3	7	9	0.93	
Cellulose/Syn fibers - Inside	1038	1703	825	952	615	553	567	1153	550	1661	782	543	912	0.45	
Cellulose/Syn fibers - Outside	442	293	251	124	192	293	226	152	154	197	176	151	221	0.40	
Opaque Dust - Inside	3621	5145	5431	4024	4690	2271	6820	5953	4130	18250	7087	4308	5978	0.69	
Opaque Dust - Outside	18116	17433	18613	11103	8212	7909	8961	9436	9125	18611	15398	16020	13245	0.34	
Mineral Dust - Inside	6587	10167	13652	11103	15169	4626	12575	12613	19356	50601	21427	6217	15341	0.79	
Mineral Dust - Outside	17514	8524	27844	26471	14452	10933	18677	15259	12377	26475	14556	14456	17295	0.37	

REGION		Total #			Commercial	
Building Type	* WC	Buildings Inspected			Building Type	Total
Residential	161	161			Schools	6
***Commercial	181	181 183			Hospital / Medical	51
		Indoor Outdoor only			Office	120
* WC = West Coast (Mixed Vancouver Canada, Central California, Southern California)					Other (labs, stores, etc.)	6

* The monthly "arithmetic mean" values for indoor "Total" and "Aspergillus/Penicillium" spores are positively skewed by isolated high measurements associated with some suspect problem buildings.

** Water-Indicating fungi (Chaetomium, Stachybotrys, and Ulocladium) are often associated indoors with chronic moisture.

*** Commercial / office buildings include all buildings that are not single family residences

Note: Because indoor mold spore concentrations tend to be exponentially or lognormally distributed (especially when indoor growth is present), statistical database comparisons using limited data should be compared by using the median (i.e. 50th percentile) and other "percentile frequency of occurrence" ranges. The AIR PROFILE™ exposure ranking system for mold spores and other dust categories is based on using the 50th, 75th, 90th, 95th, and 99th percentiles to establish six (6) color-coded classification categories (Level 1 - 6 respectively).



AIR PROFILE™ INDOOR AIRBORNE EXPOSURE CLASSIFICATION SYSTEM

Indoor Airborne Mold Spore and Dust Concentrations By Region (Cts/m³) (Combined Commercial and Residential Buildings)

AVERAGE NATIONWIDE INDOOR PERCENTILE RANKING DATA - (Used in the EAA Comparison Summary Report)															
Classification	Percentile	Total	Asp/Pen	WI	* OS	HYP	Al/Fn	Insect	Pollen	SCF	FG	CE/SYN	OPA	MIN	** FIRE
Elevated - 6	>99%	37562	21555	233	15774	338	949	1051	37	29900	648	5894	41325	132580	N/A
Elevated - 5	> 95%	11670	3488	91	8091	169	474	526	13	14700	85	1780	12700	41290	1000
Atypical - 4	> 90%	6116	1010	46	5060	57	237	179	7	9600	29	1140	7850	22160	N/A
Atypical - 3	> 75%	1640	137	23	1480	29	137	60	3	5723	8	611	3670	9090	300
Typical - 2	> 50%	395	18	11	366	11	91	57	3	3050	4	291	1810	4400	100
Typical - 1	< 50%	395	18	11	366	11	91	57	3	3050	4	291	1810	4400	100

* Frequency of detection 88% 36% 3% 88% 21% 0.3% 0.8% 10% 99% 24% 96% 100% 100% **~40%

** The Fire/combustion particle category is preliminary data for all buildings and was not analyzed (N/A) or separated by region. All of the fire residue sample data were collected in a separate database of buildings not associated with a fire-related complaint. Approximately 40% of the samples were measured to be below a detection limit of ~50cts/m³ (left censored). The classifications are based on their differential above twice the detection limit (i.e. 100cts/m³).

The average nationwide combined data is used as the basis for assigning the color-coded exposure classifications in the **AIR PROFILE™** Comparison Summary Charts provided with the EAA laboratory reports. The East Coast / Midwest data and the West Coast data provided below should be considered when a more concise regional data comparison is required. * Outside mold category is estimated by subtracting the Asp/Pen & WI fungi from the total spores

EAST COAST/MIDWEST INDOOR PERCENTILE RANKING DATA															
Classification	Percentile	Total	Asp/Pen	WI	* OS	HYP	Al/Fn	Insect	Pollen	SCF	FG	CE/SYN	OPA	MIN	FIRE
Elevated - 6	>99%	39555	25285	282	13988	576	1096	1652	27	19944	572	3409	28875	112000	N/A
Elevated - 5	> 95%	13375	4520	116	8739	113	548	826	14	10900	58	1298	9506	28520	N/A
Atypical - 4	> 90%	7200	1320	58	5822	57	274	341	7	8222	28	960	5908	15860	N/A
Atypical - 3	> 75%	1920	169	29	1722	29	137	71	7	5080	14	549	3110	8000	N/A
Typical - 2	> 50%	452	18	15	419	11	91	57	7	2770	7	282	1590	4180	N/A
Typical - 1	< 50%	452	18	15	419	11	91	57	7	2770	7	282	1590	4180	N/A

* Frequency of detection 90% 38% 4% 90% 20% 0.2% 0.7% 8% 98% 25% 95% 100% 100% N/A

* Outside mold category is estimated by subtracting the Asp/Pen & WI fungi from the total spores

WEST COAST INDOOR PERCENTILE RANKING DATA															
Classification	Percentile	Total	Asp/Pen	WI	* OS	HYP	Al/Fn	Insect	Pollen	SCF	FG	CE/SYN	OPA	MIN	FIRE
Elevated - 6	>99%	19124	9220	89	9815	576	902	488	40	43569	771	8835	75442	216830	N/A
Elevated - 5	> 95%	6500	1293	61	5146	226	451	244	20	21485	114	3241	22650	78710	N/A
Atypical - 4	> 90%	3550	456	30	3064	113	226	122	10	14880	50	1800	12200	36630	N/A
Atypical - 3	> 75%	988	58	15	915	57	127	62	5	7530	25	819	5628	14400	N/A
Typical - 2	> 50%	198	17	8	173	12	94	46	5	3715	12	373	2525	5190	N/A
Typical - 1	< 50%	198	17	8	173	12	94	46	5	3715	12	373	2525	5190	N/A

* Frequency of detection 84% 31% 2% 84% 23% 0.8% 1.2% 13% 99% 22% 99% 100% 100% N/A

* Outside mold category is estimated by subtracting the Asp/Pen & WI fungi from the total spores

Geometric extrapolation between percentile categories was used when an insufficient number of samples were collected to establish the 90th, 95th, and/or 99th percentiles, or when a significant number of measurements are *left-censored* (i.e. the concentrations are commonly found below the limit of detection). The categories where this approach has been applied include Water-indicating (W.I.) mold spores, Hyphal fragments, Algal and fern spores, Insect parts, Pollen, and Fiberglass fibers.

Mold / bioaerosols - Asp/Pen = Aspergillus/Penicillium, WI = Water-indicating spores, OS = Outside/outdoor spores, HYP = Fungal Hyphal/mycelia fragments
Al/Fn = Algal & Fern spores, Insect = Insect parts, SCF = Skin Cell Fragments

Other Particles - FG = Fiberglass, CE/SYN = Cellulose/Synthetic fibers, OPA = Opaque/black particles, MIN = Mineral particles, Fire = Fire residue particles

* Frequency of Detection - Defined as the percentage of samples in each category that are measured above the detection limit.

Regional Building Distribution			Total # of buildings		%	Estimated Problem & Non-Problem Buildings			
West / Coastal (W)			345		29%	Problem	87	7%	
Central / Midwest (C)			100		8%	Non-problem	304	25%	
East Coast / Northeast (EC)			765		63%	Not determined	819	68%	
Total			1210	(Indoor sampling only)		Problem Building - Known "Complaint" area or mold exposure condition with 2 or more mold samples >90 th percentile range.			
						Non-problem building - Known "Non-complaint" area or where the data set (consisting of 3 or more samples) are less than the 75 th percentile.			

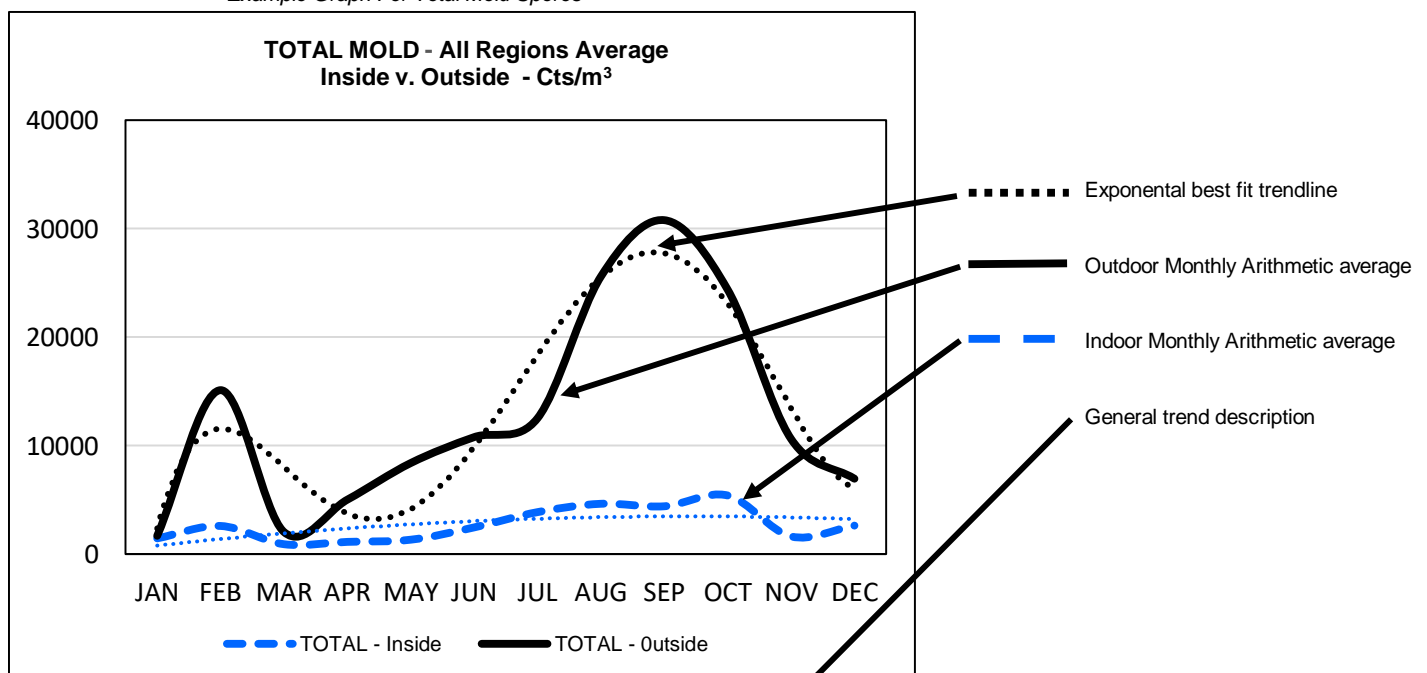
MONTHLY GRAPHICAL AIRBORNE SUMMARY GUIDELINES

The graphs on the following pages are monthly summaries provided to illustrate the seasonal and regional trendlines between the indoor and outdoor measurements for each dust particle category. The monthly mean (average) airborne concentration measurements for the East Coast / Midwest (MVEC) and the West Coast (WC) regional data, and the exponential (best fit) trendline are provided in each of the graphs. The presence or absence of any seasonal (monthly) trends, and the potential correlation between the inside and outside concentrations within each category are summarized below.

Airborne Monthly Concentration Maximum Trends Observed by Particle Category

Particle Category	Seasonal Trends	East Coast / Midwest Trends (MVEC)	West Coast Trends (WC)	Correlation Between Inside and Outside Samples
Mold Spores (Total) - Outside	Yes - high	FEB-MAR, AUG-OCT	FEB-MAR, SEP-OCT	Low - No correlation
Mold Spores (Total) - Inside	Yes - low	JUL-OCT	No trend	
Mold Spores (ASP/PEN) - Outside	Yes - low	AUG-OCT	None	Low - No correlation
Mold Spores (ASP/PEN) - Inside	Yes - low	JUL-SEP	JUN-SEP	
Pollen - Outside	Yes - high	APR-AUG	FEB-MAY	Low - No correlation
Pollen - Inside	No trend	No trend	No trend	
Skin cell fragments - Outside	No trend	No trend	No trend	No correlation
Skin cell fragments - Inside	Yes - low	No trend	FEB, SEP-NOV	
Fiberglass fibers - Outside	No trend	No trend	No trend	No correlation
Fiberglass fibers - Inside	No trend	No trend	No trend	
Cellulose / synthetic fibers - Outside	No trend	No trend	No trend	No correlation
Cellulose / synthetic fibers - Inside	No trend	No trend	No trend likely	
Opaque particles - Outside	Yes - moderate	OCT-DEC	SEP-FEB	Low correlation (found in WC data only)
Opaque particles - Inside	Yes - low	DEC-JAN	SEP-NOV	
Mineral dust - Outside	Yes - moderate	SEP-DEC	No trend	No correlation
Mineral dust - Inside	Yes - low	SEP-DEC	SEP-NOV	

Example Graph For Total Mold Spores

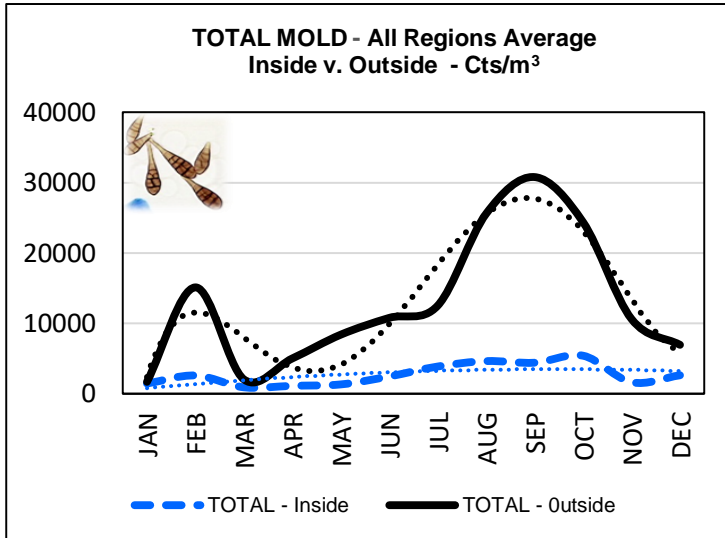


Late Winter and Fall outdoor maximum trend present

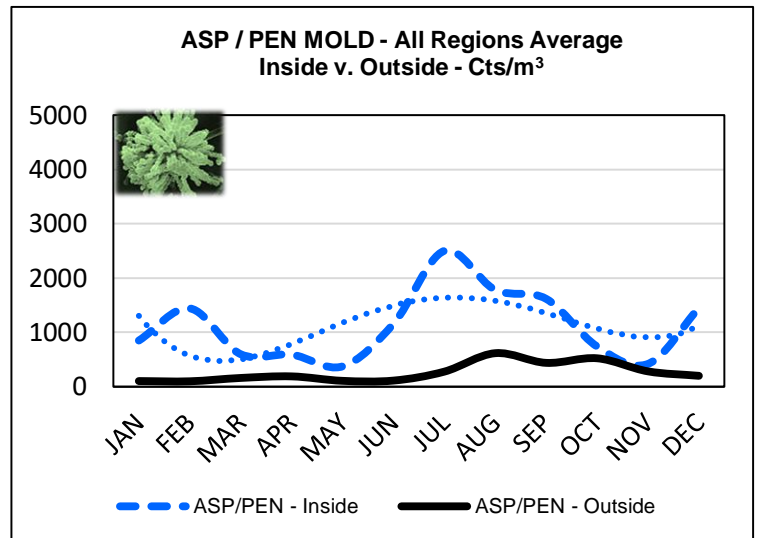
GRAPHICAL DATABASE SUMMARY (Monthly Variation by Region)

Mold Spore Concentrations (All Commercial and Residential Data) - Arithmetic Average Regional Trend Levels

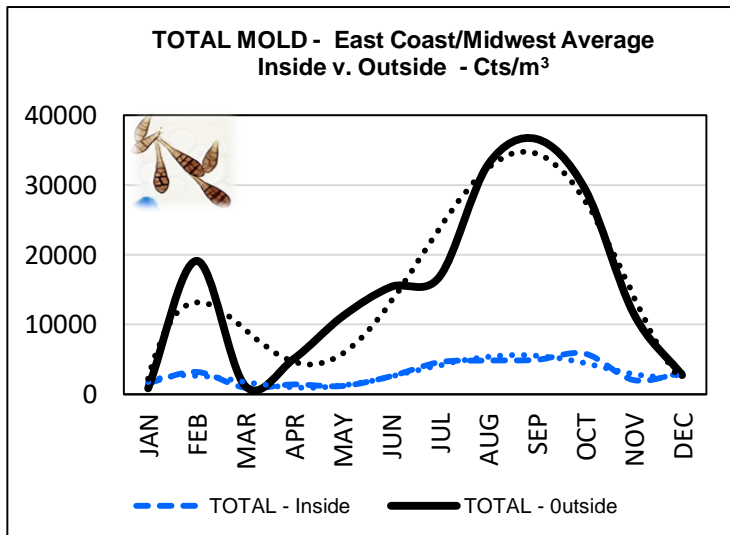
Exponential Trend Line =



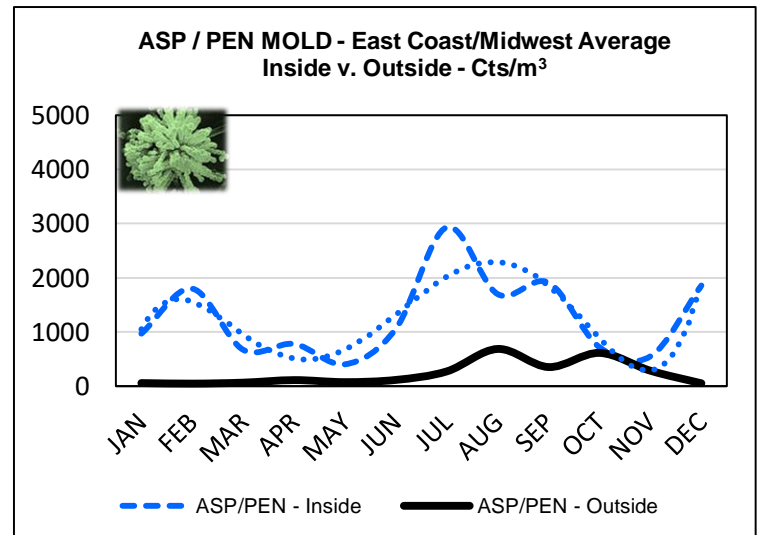
Late Winter and Fall outdoor maximum trend present



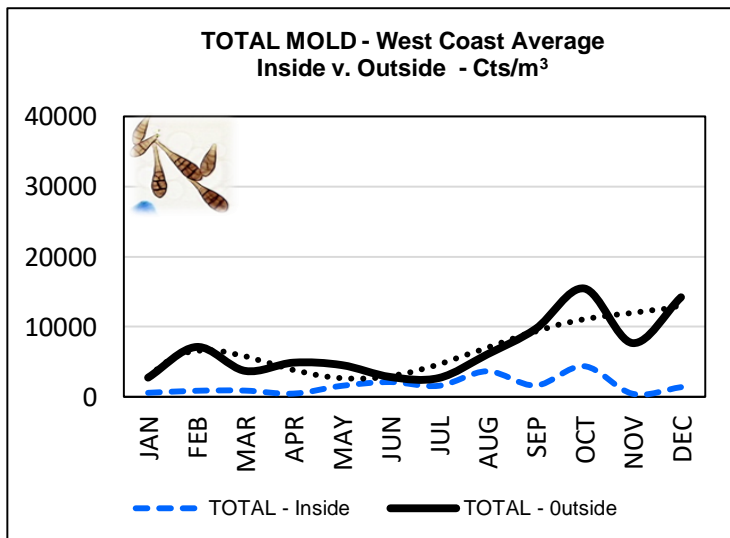
Mid-Summer indoor elevation trend possible



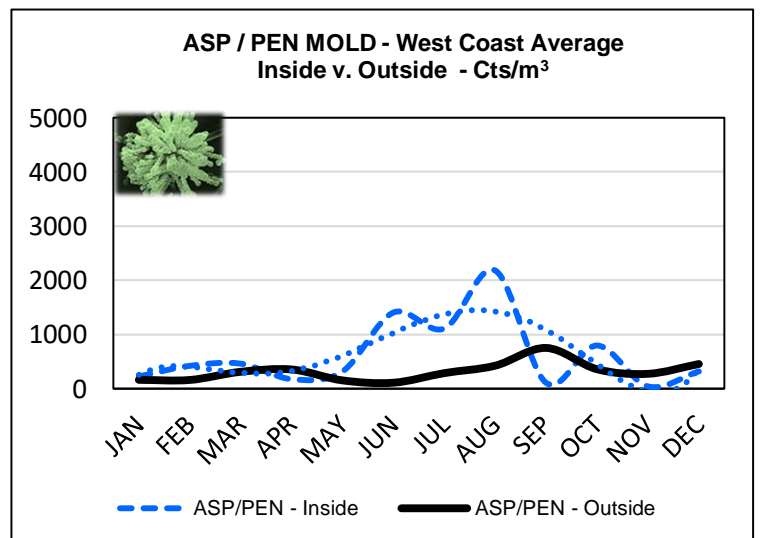
Late Winter and Summer outdoor maximum trend present



Mid-summer indoor elevation trend possible



Late Winter and Fall outdoor maximum trend present

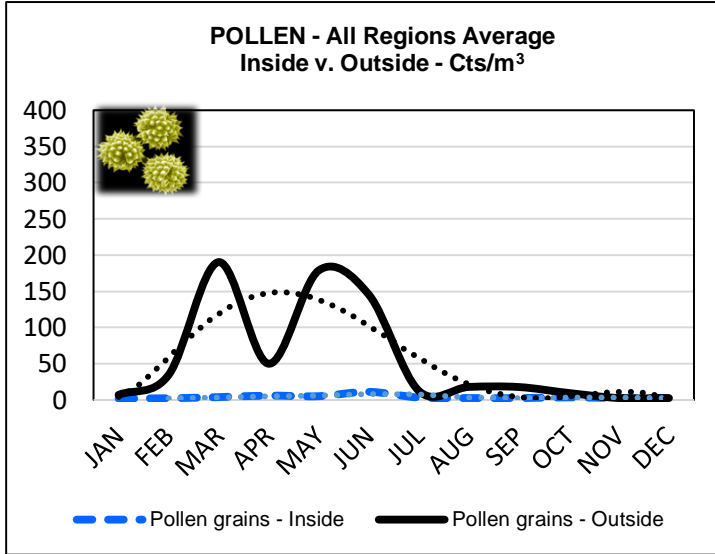


Mid-Summer indoor elevation trend present

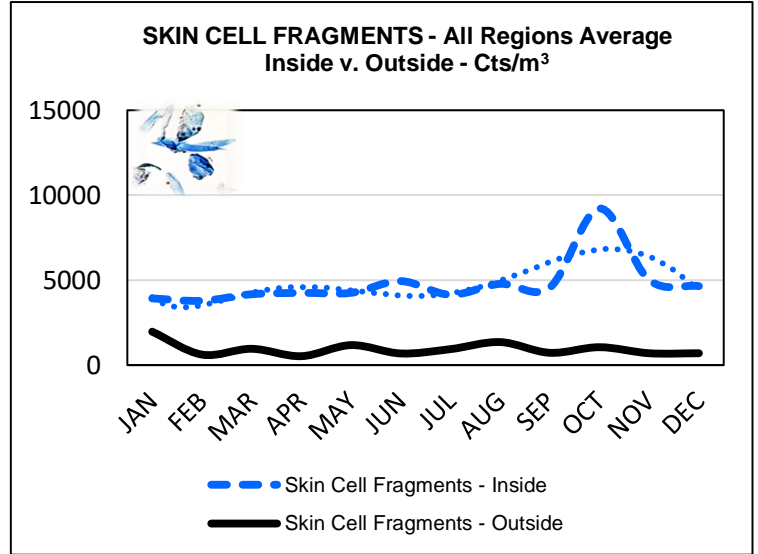
GRAPHICAL DATABASE SUMMARY (Monthly Variation by Region)

Pollen and Skin Cell Fragments (All Commercial and Residential Data) - Arithmetic Average Regional Trend Levels

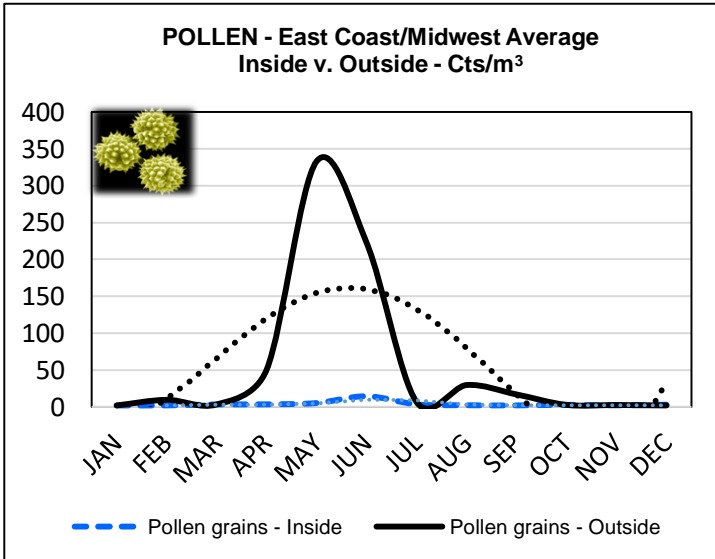
Exponential Trend Line =



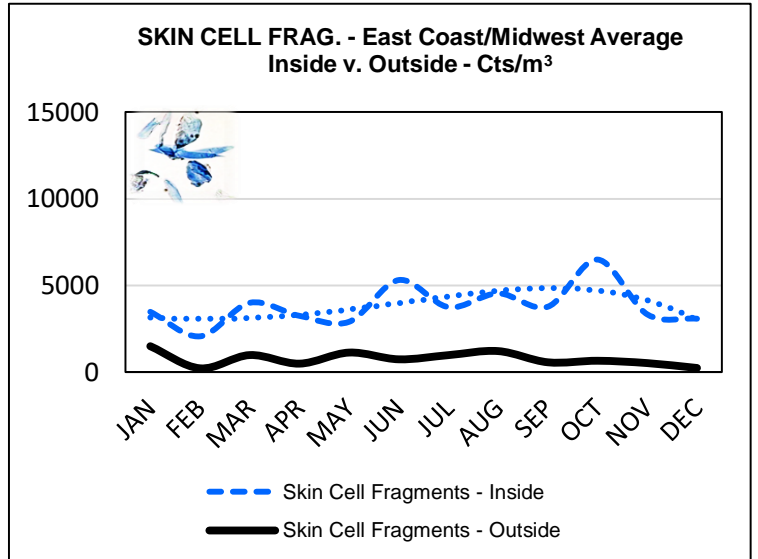
Spring - Summer bimodal trend present (regional effect)



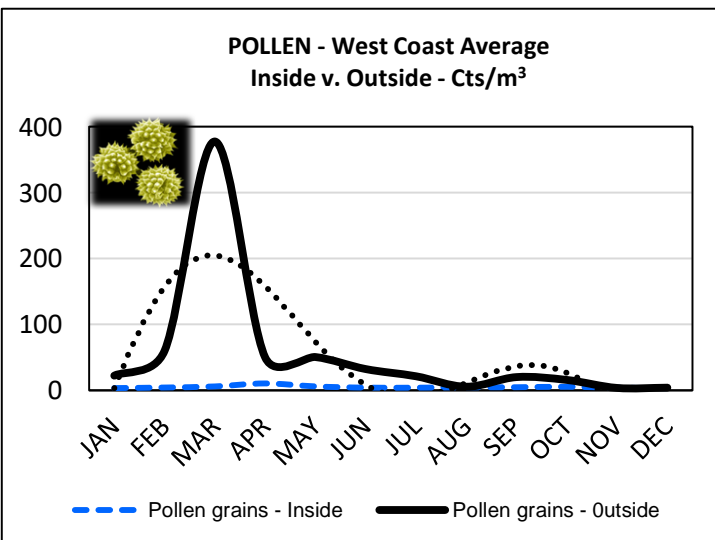
Fall maximum trend present (primarily due to West Coast data)



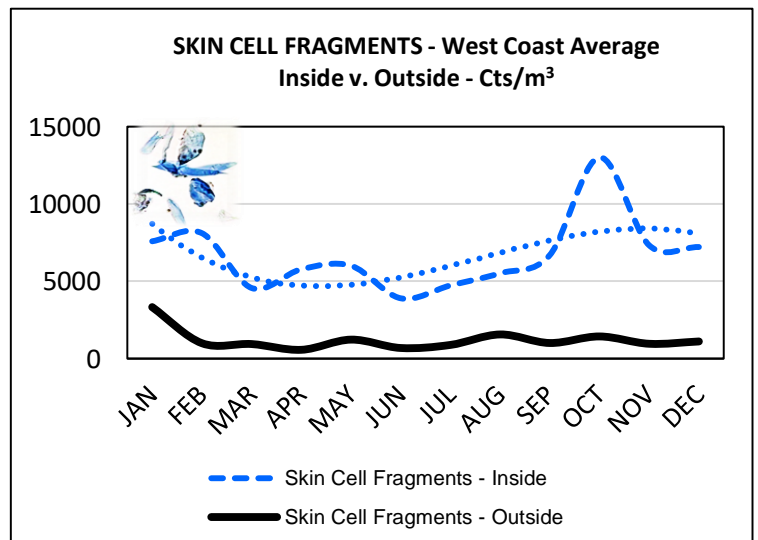
Late Spring-Summer outdoor maximum present (regional)



No monthly trend present



Early Spring outdoor maximum trend present (regional)

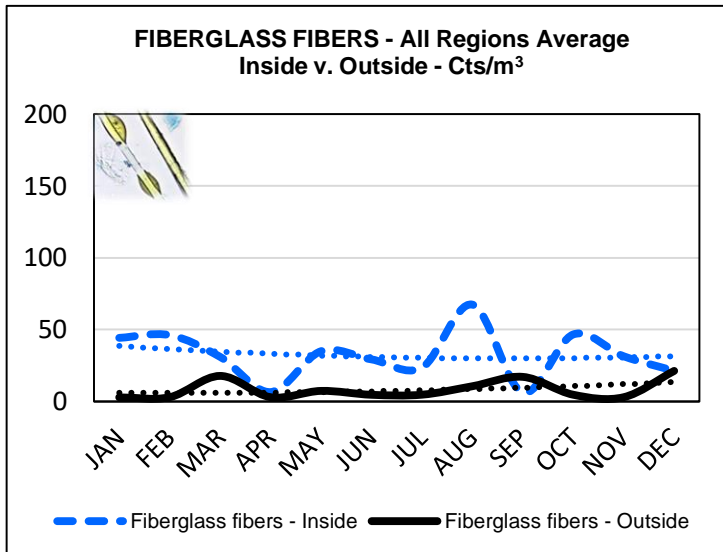


Fall-Winter indoor elevation trend possible

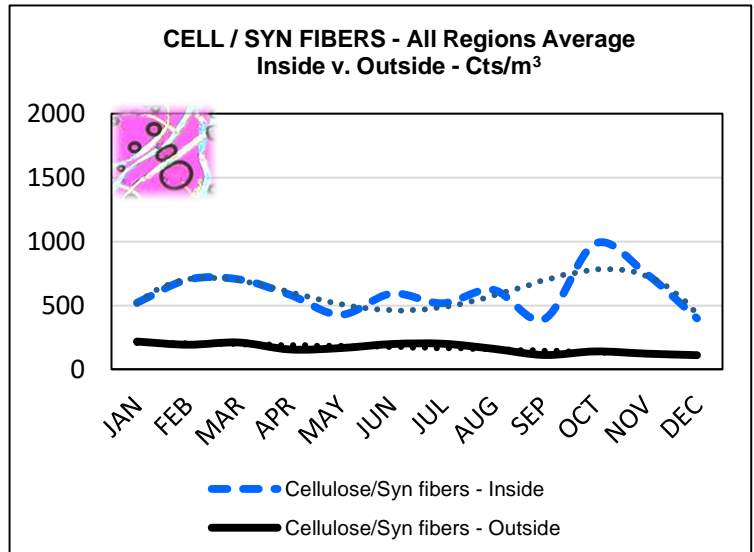
GRAPHICAL DATABASE SUMMARY (Monthly Variation by Region)

Fiberglass & Cellulosic/Synthetic Fibers (All Commercial and Residential Data) - Arithmetic "Average" Trend Levels

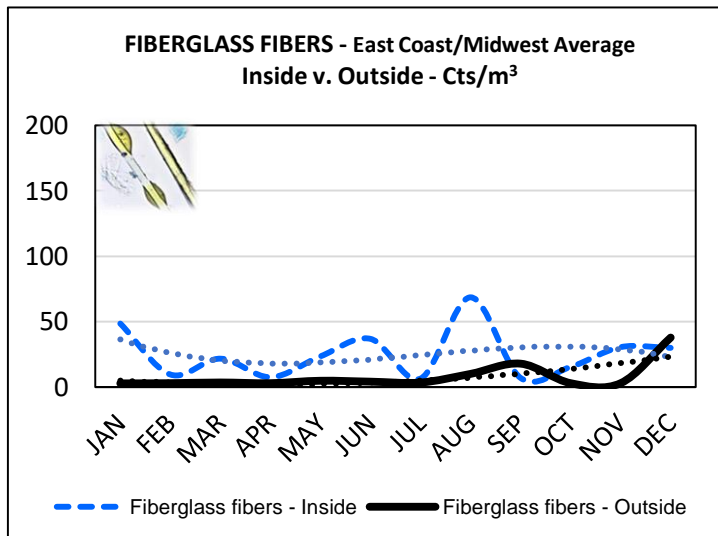
Exponential Trend Line =



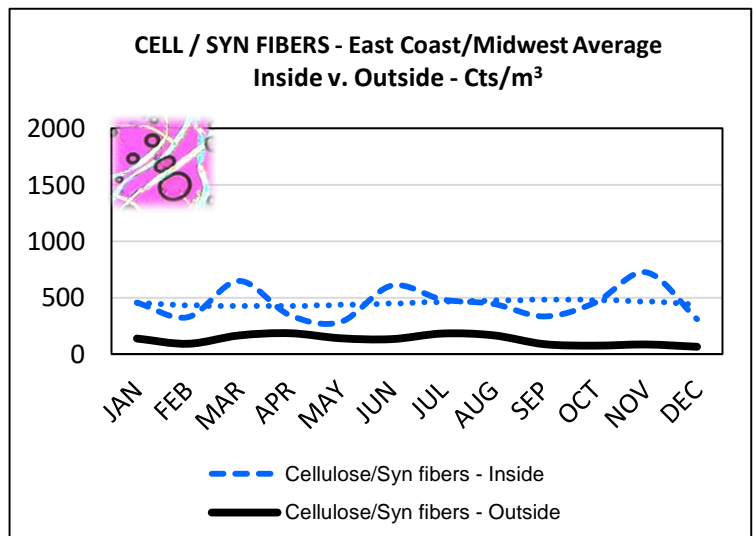
No monthly trend present (Very low average concentrations)



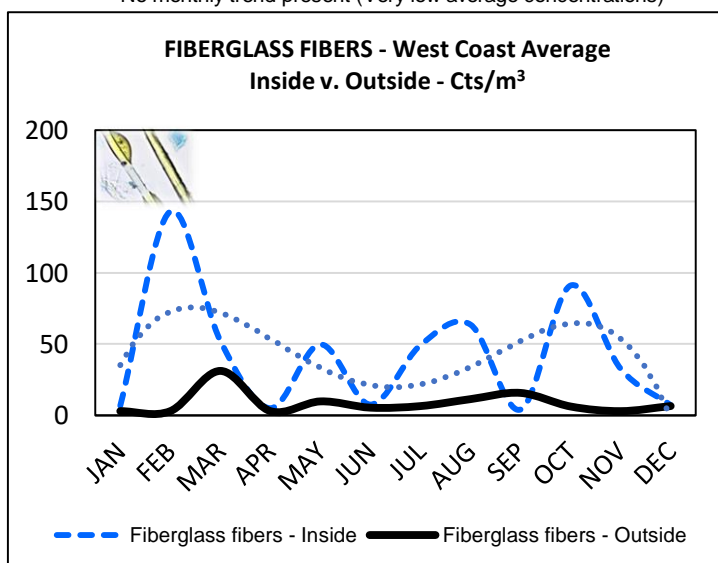
Slight Winter and Fall indoor elevation trend possible



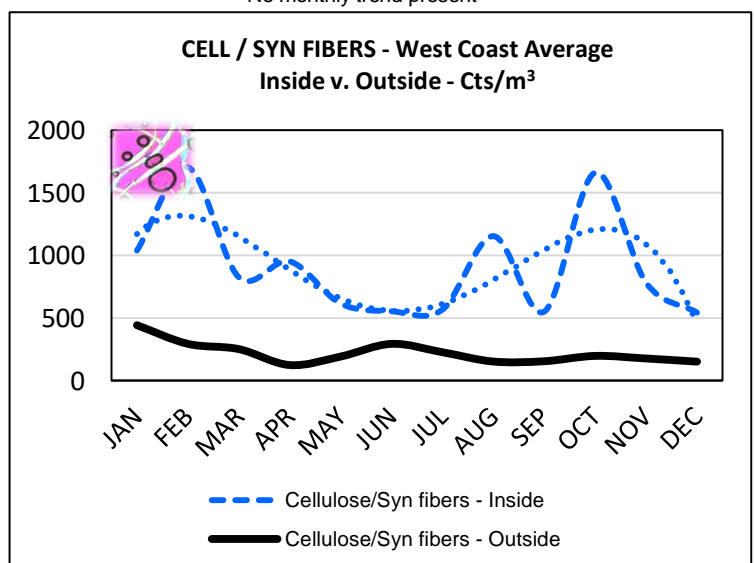
No monthly trend present (Very low average concentrations)



No monthly trend present



No monthly trend present (Very low average concentrations)

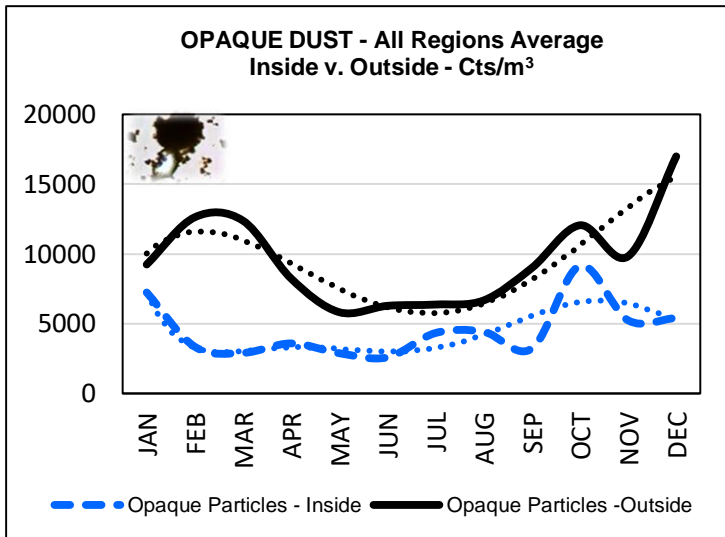


Winter and Fall indoor elevation trend present

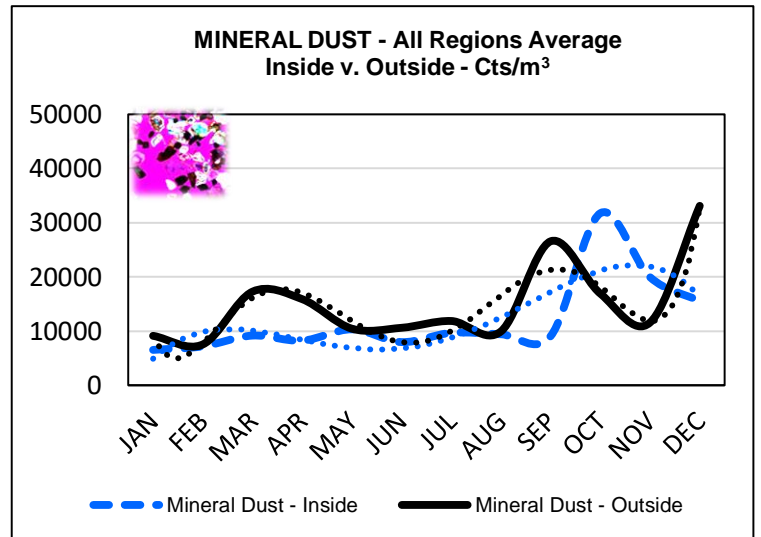
GRAPHICAL DATABASE SUMMARY (Monthly Variation by Region)

Crystalline Mineral & Opaque Dust (All Commercial and Residential Data) - Arithmetic Average Regional Trend Levels

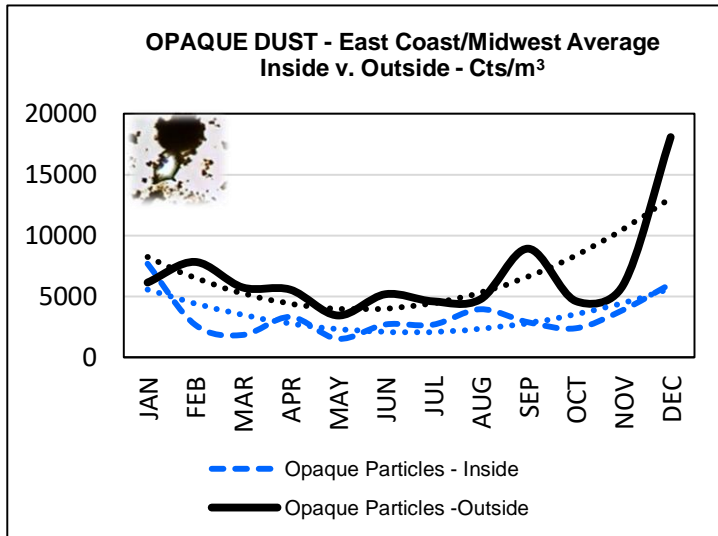
Exponential Trend Line =



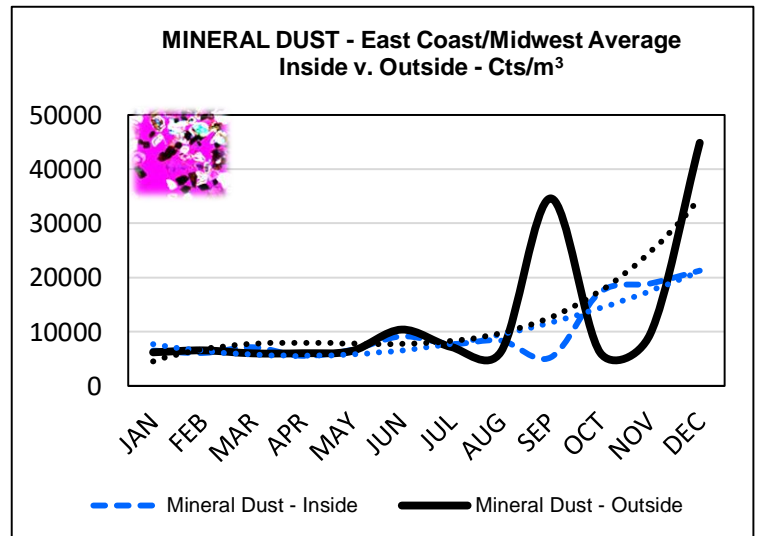
Fall-Winter monthly elevation trends present



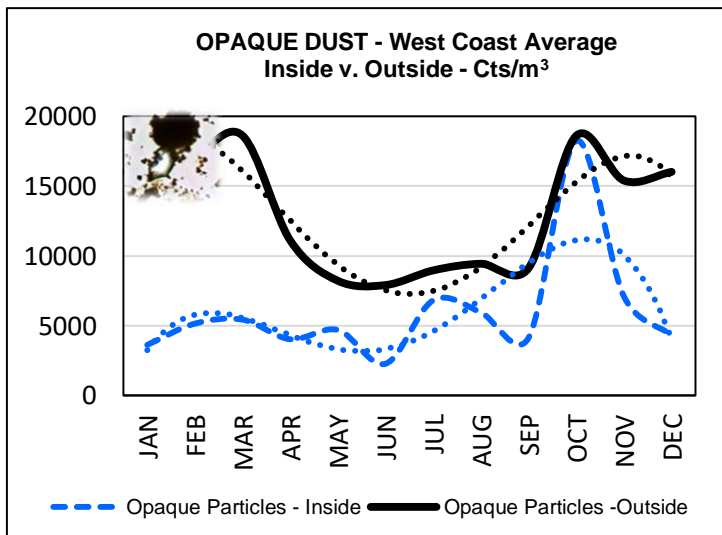
Spring and Fall indoor & outdoor elevation trend present



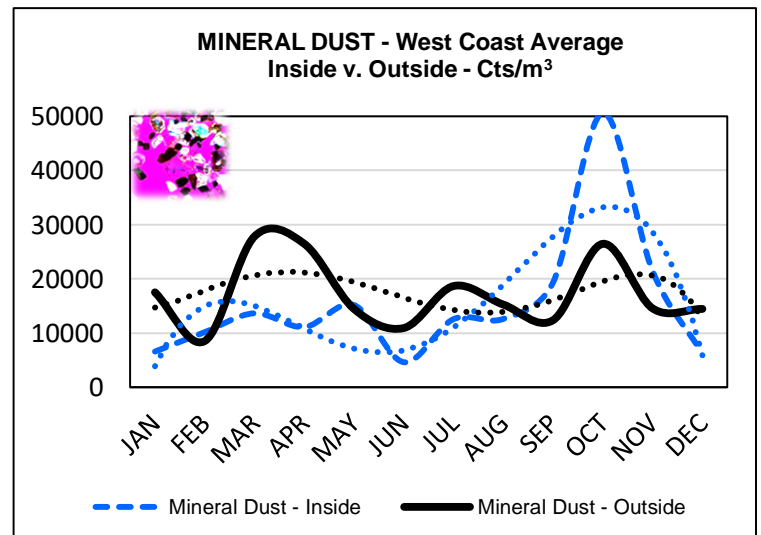
Fall-Winter outdoor monthly maximum trend present



Fall indoor & outdoor maximum trend present



Fall-Winter outdoor and indoor monthly maximum trends present



Spring and Fall indoor & outdoor maximum trend present

GRAPHICAL DATABASE SUMMARY (Monthly All Nationwide Data)

Mold Spore and Dust Concentrations - Commercial versus Residential

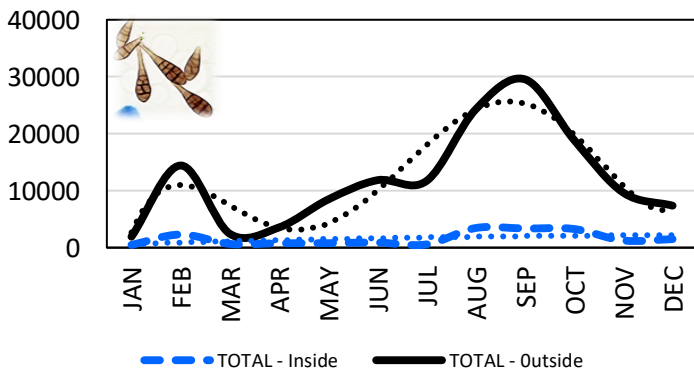
ALL COMMERCIAL BUILDINGS

Classification	Percentile	Total	Asp/Pen	WI	OS	HYP	Al/Fn	Insect	Pollen	SCF	FG	CE/SYN	Opa	Min
Elevated - 6	>99%	25170	9173	57	15940	384	1016	288	29	26658	698	26658	39102	125230
Elevated - 5	> 95%	7138	1238	29	5872	96	508	144	13	12800	73	12800	11200	33780
Atypical - 4	> 90%	3335	339	14	2982	57	254	98	7	9149	28	9149	7036	19730
Atypical - 3	> 75%	858	46	7	805	29	148	58	2	5353	14	5353	3440	8573
Typical - 2	> 50%	226	14	1	211	9	91	46	2	2930	3	2930	1710	4150
Typical - 1	< 50%	226	14	1	211	9	91	46	2	2930	3	2930	1710	4150
Frequency of detection		85%	26%	2%	85%	15%	0.3%	0.8%	9%	99%	24%	96%	100%	100%

ALL RESIDENTIAL BUILDINGS

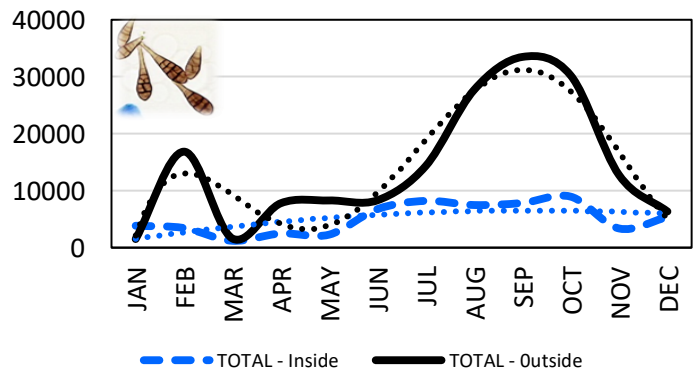
Classification	Percentile	Total	Asp/Pen	WI	OS	HYP	Al/Fn	Insect	Pollen	SCF	FG	CE/SYN	Opa	Min
Elevated - 6	>99%	74549	64540	576	*9433	768	1054	3072	45	55502	608	7936	47344	254680
Elevated - 5	> 95%	20610	10370	57	10183	274	527	1536	18	27060	192	4697	28430	109600
Atypical - 4	> 90%	12500	3978	29	8494	168	264	768	13	20420	58	2150	18240	68960
Atypical - 3	> 75%	4455	734	14	3707	57	132	197	7	11250	11	1190	8320	21200
Typical - 2	> 50%	1240	113	3	1124	16	94	57	4	6100	3	621	3600	7620
Typical - 1	< 50%	1240	113	3	1124	16	94	57	4	6100	3	621	3600	7620
Frequency of detection		97%	61%	7%	97%	34%	0.5%	0.9%	22%	99%	30%	99%	100%	100%

COMMERCIAL - TOTAL MOLD - Average Inside v. Outside - Cts/m³



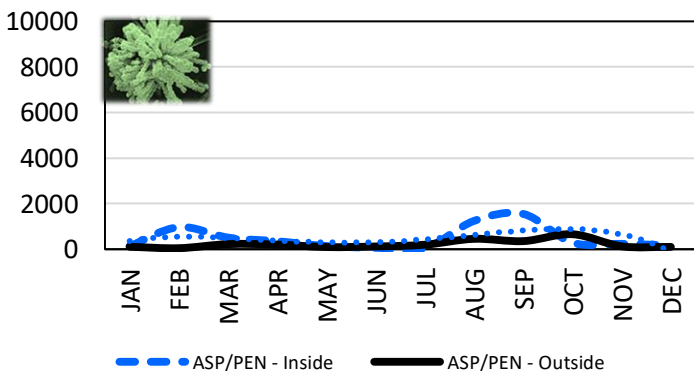
Winter and Fall outdoor maximum trends present

RESIDENTIAL - TOTAL MOLD - Average Inside v. Outside - Cts/m³



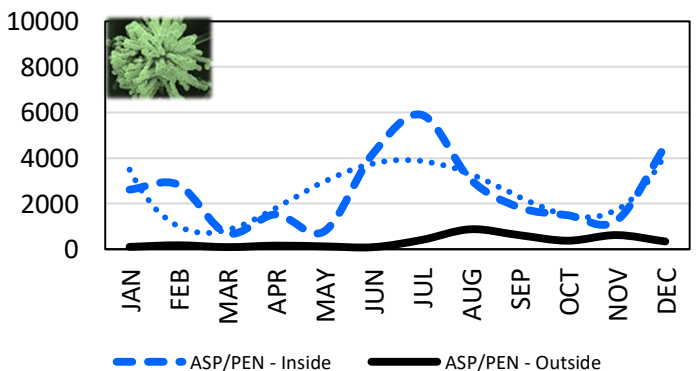
Possible Spring and Fall outdoor elevation trend, indoor spring minimum

COMMERCIAL - ASP / PEN MOLD - Average Inside v. Outside - Cts/m³



Possible Spring and Fall indoor maximum trends present

RESIDENTIAL - ASP / PEN MOLD - Average Inside v. Outside - Cts/m³

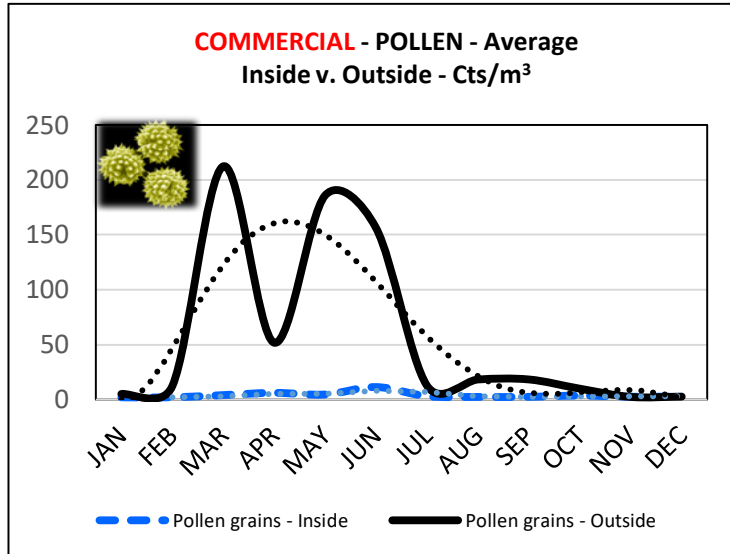


Possible Winter and Summer indoor maximum trend present

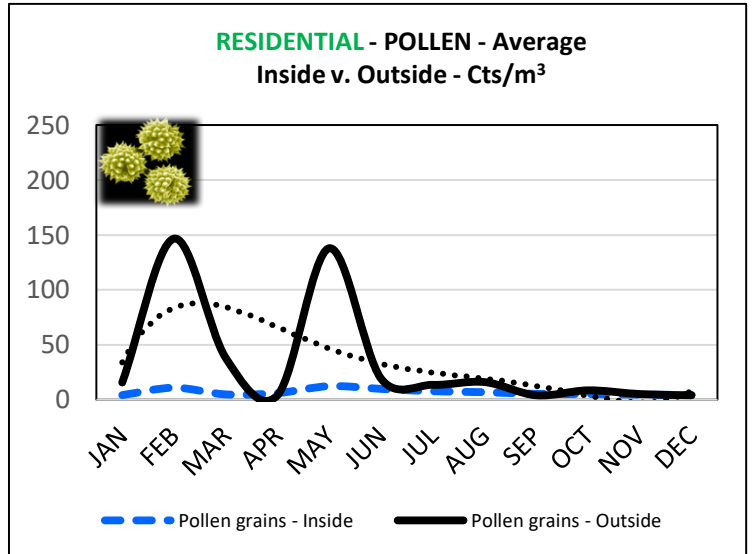
GRAPHICAL DATABASE SUMMARY (Monthly All Nationwide Data)

Pollen, Skin Cell Fragments, Cellulosic Fibers - Commercial verses Residential - Arithmetic Average Regional Trend Levels

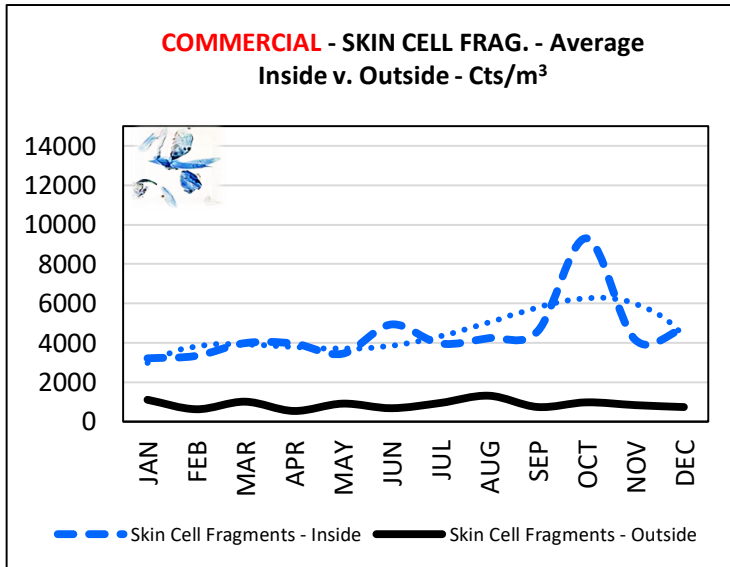
Exponential Trend Line =



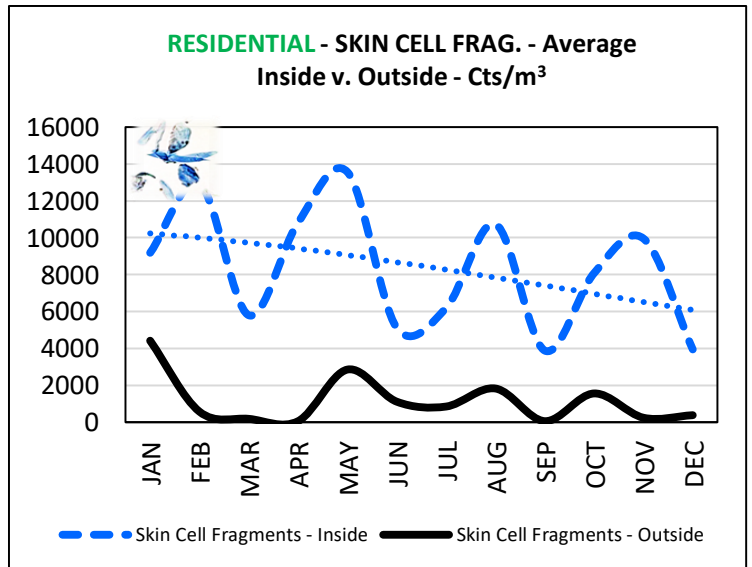
Mixed Spring outdoor elevation trends present



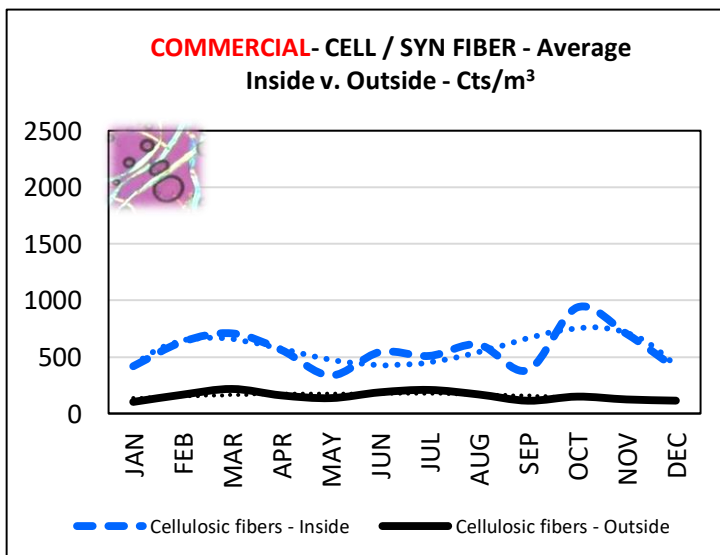
Mixed Spring outdoor elevation trends present



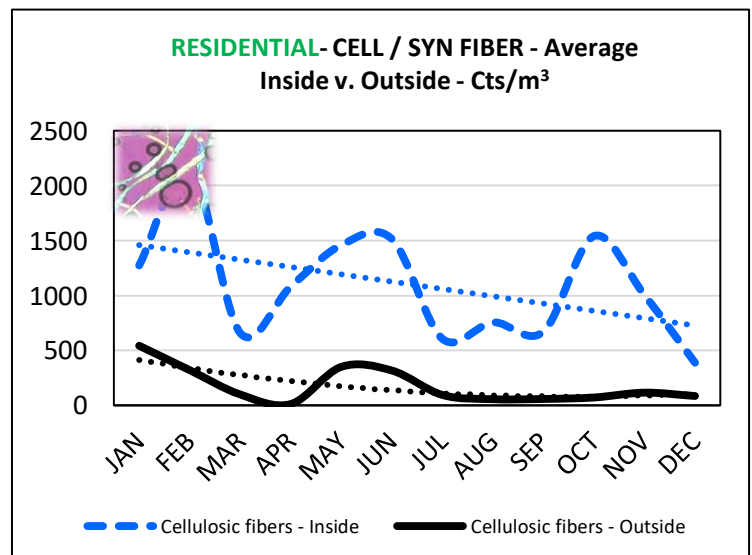
Possible Fall indoor maximum trend present



Indoor trend not present



Indoor outdoor trends likely not present

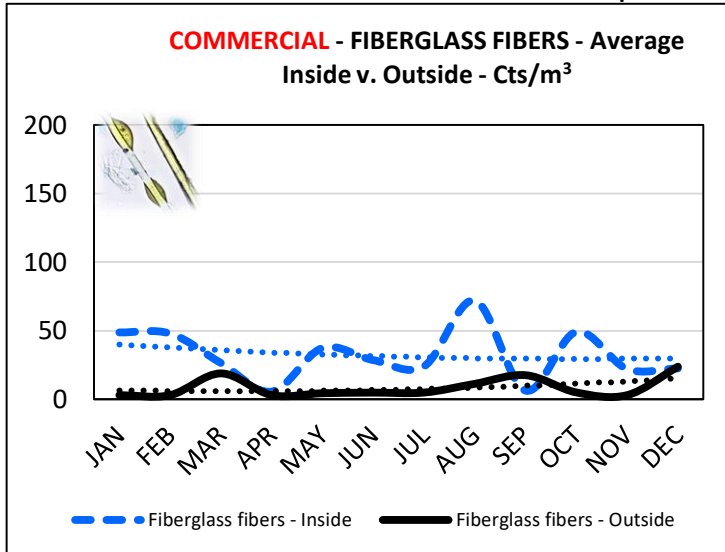


Indoor outdoor trends likely not present

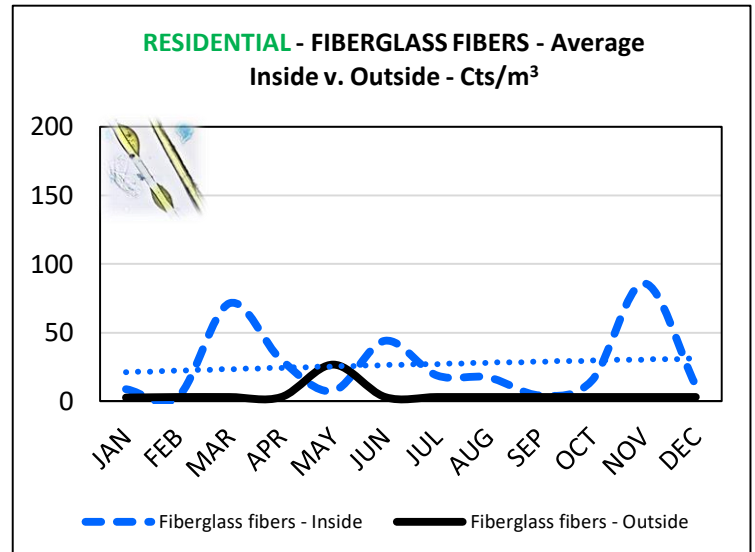
GRAPHICAL DATABASE SUMMARY (Monthly All Nationwide Data)

Fiberglass, Mineral particles, Opaque particles - Commercial versus Residential - Arithmetic Average Regional Trend Levels

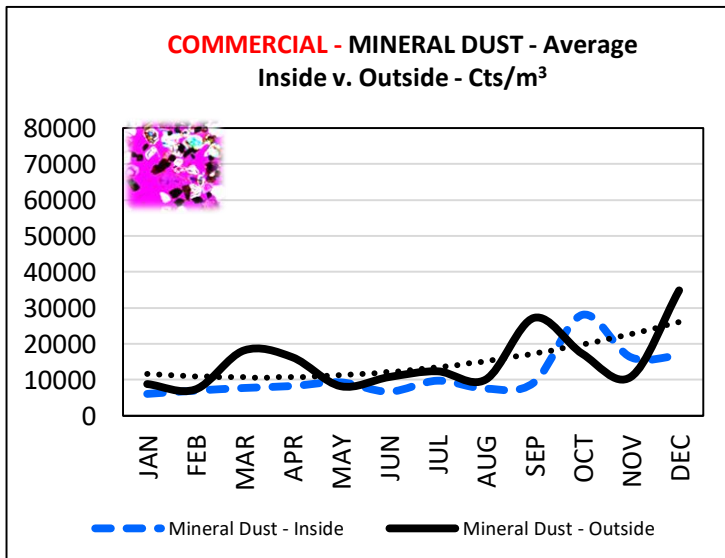
Exponential Trend Line =



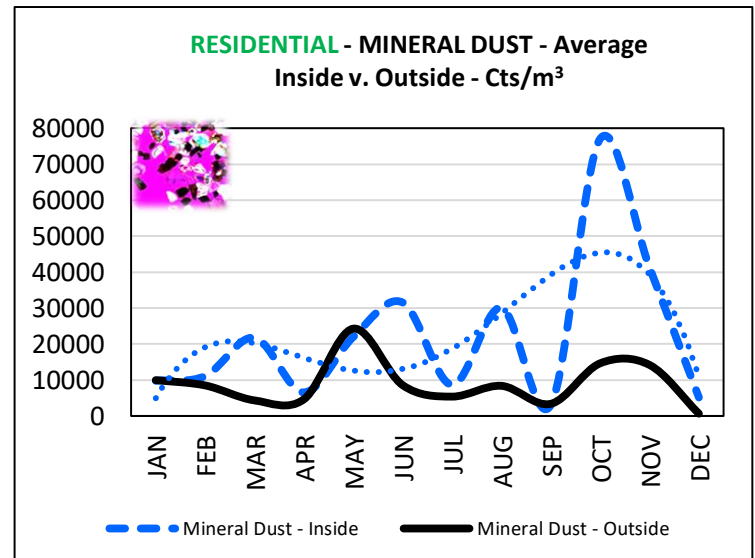
No trends present (Very low concentrations)



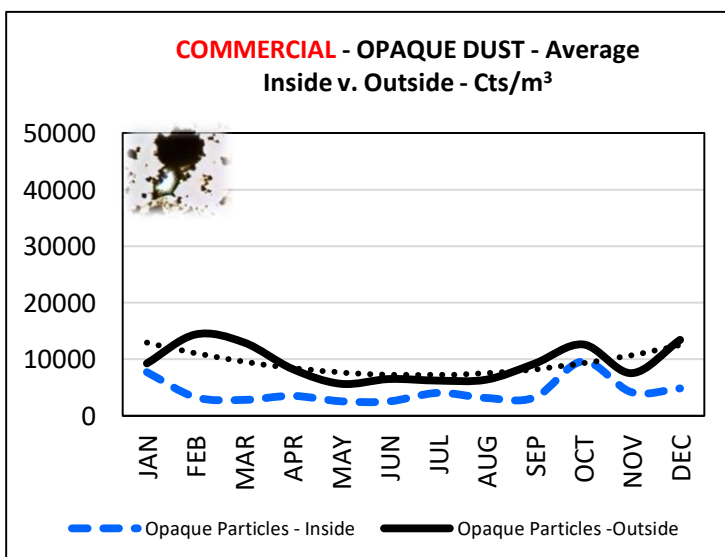
No trends present (Very low concentrations)



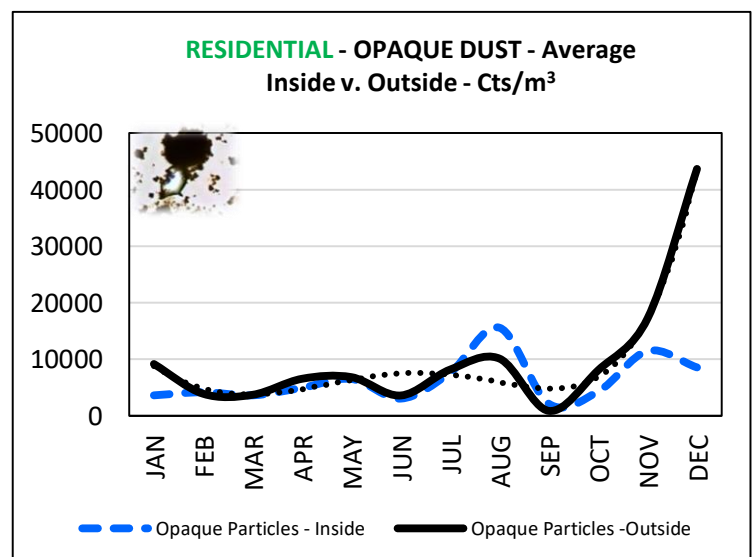
Possible Fall outdoor and indoor maximum trend



Possible Fall indoor maximum trend



No significant trends present



Possible Fall-Winter outdoor maximum trend