Sick Buildings - Tracking Down the REAL Culprit

Conventional wisdom says that, if a definite cause cannot be identified for a "sick building" problem, it must be the fault of the energy (HVAC) system. If you accept that premise, you have fallen into a "logic trap".

Challenging the "Logic Trap"

It's time to challenge the assumptions which lead to this unsatisfactory conclusion. The Indoor Environmental Quality (IEQ) in a building and the energy system are inextricably bound, but, contrary to popular belief, the energy system is seldom the cause of IEQ problems. A poorly designed or maintained system definitely contributes by creating conditions which encourage the spread and severity of problems, but the source and blame for most IEQ problems lies elsewhere. An energy system conceived as part of an integrated total environmental program provides building occupants not only with physical comfort but also with optimum conditions for productivity and health. Conversely, a system that ignores environmental effects and focuses solely on energy efficiency can cost millions of dollars in lost time, lost productivity, occupant healthcare and ultimately in renovation or remediation.

The Energy System Indictment

IEQ has become a major focus of legal, public and regulatory attention, and our modern, energy efficient buildings stand accused. Is the indictment valid or flawed? To answer that question we must reexamine how we manage and assess our indoor environments. Even more, we need to challenge the conventional wisdom which says that "toxic" chemicals are found at high levels, sick building problems must be caused by a "failure" of the air handling system. Our technical ability to model and control the indoor environment and to test for potentially toxic chemicals has undergone a step change improvement in recent years, but we also have seen a dramatic increase in human health problems in our offices, schools, factories, and homes. Why? Is the SBS phenomena simply an overblown exploitation of another new victim by the sensationalist media and greedy lawyers? If believing that makes you feel good, so be it, but there is a far better answer. The problem is real, but our analysis model is based on incorrect assumptions.

High Tech Problems - High Tech Solutions

We have assumed that SBS must be a high tech problem with a high tech cause. The chemical industry was the perfect villain. A few high visibility problems were directly tied to chemical exposure. Media inspired "chemophobia" and the industry's own scientific arrogance did the rest. In our politically correct indictment of "chemicals", we ignored the fact that our preferred cause correlated poorly with our problem. There was and is a far better cause/problem correlation, but it is nowhere near as exciting or newsworthy. In fact, it is downright common and dull. Plain old mold and mildew provide a much stronger cause and effect relationship. Despite repeated alerts

from microbiologists and medical researchers (too often buried in scientific journals and replete with esoteric explanations of such things as mycotoxins and aflatoxins), we all but ignored the potential danger of that fuzzy green and gray stuff that grows in the basement and smells bad. It's time to remedy that mistake.

The Fuzzy Gray Stuff

Microorganisms (or microbes) are part of our everyday lives and environments. By definition, in their smallest form they are microscopic or too small to see with the naked eye. By the time they are large enough to see, you aren't looking a one microorganism, you are looking at hundreds or millions. At that point the question isn't whether or not you have microbial contamination. You do! The appropriate questions are: "How bad?" and "How dangerous are the organisms?" In indoor environments, microbes are found on all environmental surfaces, in the air and in water associated with both normal and catastrophic situations. The few highly publicized outbreaks of Legionnaires Disease and the more complex indoor issues of today such as Sick Building Syndrome (SBS) and Building Related Illness (BRI) have begun to put microbiologists and microbiological sciences in the headlines and on the line.

BRI Defined

Technically, Building Related Illness(BRI) is defined as the clinical manifestation of occupant exposure to excessive airborne pollutants in a building. The array of typical symptoms includes headaches, burning eyes, fatigue, dizziness, flu-like maladies and upper respiratory complaints. Although these symptoms can by generated by many different things, all can be caused by microorganisms, and more and more frequently these microbes, especially fungi, are being implicated as primary and contributory factors. The buildings in which these organisms thrive are not simple environments. They are complex ecosystems which are made even more complex by the constant change a building undergoes throughout its life cycle. Microbial contamination, in varied but inevitable ways, will occur at different stages of this life cycle and will be manifested in many ways.

The Building Biosphere

A building can be thought of as a biosphere, the organisms are in a constant flux. Nutrient and humidity changes and alteration of life-limiting (toxic) surfaces allow microbes to adjust and often adapt to the ever changing conditions in their environment. Associated with buildings and their inhabitants are the full range of microorganisms: bacteria, fungi, viruses, rickettsia and algae. Each of these groups of organisms has its own niche and each fills a natural role in the microcosms of a building. No absolute methods exist for retrieval, identification or linkage of microbes found in buildings to many of the human symptoms that are presented. Microbes are not as simple as the whole intact organisms we test, but, in fact, their somatic parts, reproductive parts and metabolites are all implicated as causative or potential human or building antagonists. Microorganisms are the only source that presents all forms of pollutants - particulates, gases and infectious biologicals. They are particularly potent in that they can amplify and cause the full breadth of discomfort, irritation, sensitization, toxic reaction and disease that we associate with indoor environmental quality.

What Causes Microbial Growth?

The microorganisms represented in a building are complex. Every element of a building, it furnishings and its people offers a home for microorganisms. Microorganisms need moisture and nutrients and more that 95% of them need to be associated with a surface. Moisture can come from catastrophic or normal events - a leaking roof, a sweating pipe, a leaking radiator, condensation on windows, condensation on more subtle surfaces where dew points are reached,

humidified air from the HVAC system or any of hundreds of other sources. A hotel or resort facility compounds the problem with the moisture from pools, spas, individual air conditioners and literally hundreds of bathrooms. This, coupled with wall to wall carpeting, draperies, wall coverings, furniture, bedding and ceiling tiles, creates ideal habitats for microorganisms. Nutrients utilized by microorganisms cam be organic material, inorganic material and /or living tissue. For example, bacteria play an important role as part of the body's microflora, and, alone with skin, are shed continuously. Given acceptable growth conditions, some types can multiply from one organism to more than one billion in just 18 hours. A building may be infested during construction and catastrophic events (particularly with fungi), but more commonly the organisms are routinely brought into the building by its occupants or air infiltration routes. Fungi (typically outdoor organisms known as mold, mildew, and yeasts) enter the building on clothing, are wafted in through open doors or are pulled in as "make up" air by the HVAC system. Bacteria follow these same routes but are primarily associated with human carriers and with very wet areas such a drain pans and places with constant or standing water.

Airborne Pollution

Although most organisms grow on receptive building surfaces, they and their spores become airborne through normal occupant traffic and activities such as vacuuming. Once airborne, the HVAC systems, chases and elevator shafts efficiently transport the microorganisms throughout the building. They settle on other receptive surfaces and quickly begin to reproduce. One good growth source for a particular organism can quickly result in outbreaks in every part of a building. Also, with the almost universal use of air conditioning, recycling air to improve energy efficiencies takes place. Yet, that recycling tends to concentrate indoor air pollutants - including microorganisms and their annoying, irritating, sensitizing and toxic by-products.

Additive or Synergistic Effects

Partially because of the common failure to find definitive causes for "sick" buildings, the additive or synergisticeffects of particulates, gases and microorganisms have come under increasing scrutiny. The short-term symptomatic relief achieved by control of microbial growth sources are strong evidence that most building health problems are not created by a single pollutant. Numerous case histories show that reports of human SBS symptoms have dropped dramatically or ceased in buildings where levels of airborne microbial contamination have been significantly reduced. This is true even where no single species of organism has been identified as dominant. Pollution problems and their effects on energy efficiency and human health are clearly generated from the complexity of our buildings, occupant habits and practices and the potency of individual and combined pollutants.

Traditional Solutions

Mold and mildew have been recognized for years as a major cause of problems in buildings; although most of the recognition had focused on odors, rot and unsightly growth rather than on human health problems. Management has struggled valiantly (but with minimal success) against mold and mildew in an effort to provide a clean, pleasant and safe environment. There has been an unending array of products, cleaners, chemicals, devices, strategies, and methods available to combat microbial problems from mildew to pathogenic bacteria.

Housekeeping procedures:

Housekeeping professionals regularly scrutinize building spaces and remove any visible growth. Detergent/sanitizer products are effective short term tools against visible mold and mildew, but some areas require harsh bleach or mildew removers. All are short term solutions and many of the products present their own toxicity problems. When musty odors develop, cleaning

personnel frequently use perfumes and fragrances to mask or disguise the problem (and the often offensive odors of the sanitizers). These can create more of a problem than they solve for allergic and sensitive individuals.

Engineering procedures:

Most tactics in this category include selection, operation, modification, and maintenance of HVAC systems to permit "better" temperature and humidity control and better filtration. This does not address microbial infestation or eliminate growth sources, but it can reduce the rate of growth of mildew. The air handling and engineering specialists have worked with filtration and extraction of pollutants but have generally concentrated on dilution. Recognizing that the severity of virtually all human toxic response is based on a combination of toxicity and dosage, the theory is that dilution of an environment with massive amounts of "fresh air" lowers the dosage level below the human response threshold and "eliminates" the problem. The initial modern attempt was ASHRAE's (The American Society of Heating, Refrigeration and Air Conditioning Engineers) Standard 62-1981. That standard established an optimum ventilation rate of 5 cubic feet of air per minute per person (cfm/person). Since this significantly diluted the concentration of pollutants in the air, immediate human health benefits were usually noticed. Unfortunately, since the pollutant sources were not being addressed, the health problems frequently returned. This was particularly true where the primary pollutant was microbiological. Chemical pollutant sources tend to be static or reducing over time, but microbial sources continue to grow and increase in output of toxins. The "answer" to the deficiencies of ASHRAE 62-1981 was ASHRAE 62-1989. This moved the Standard to a range of 15 cfm/person to 20 cfm/person in general office spaces. The latter also assumes a maximum occupancy of seven persons per 1000 square feet. As before, implementation of the standard produced immediate health and comfort benefits for occupants, but continuing problems in our modern buildings show that this dilution strategy does not address the real problems of Indoor Environmental Quality. A secondary problem is that the added energy costs associated with dilution strategies, when combined with their failure to address pollution sources, raise serious cost/benefits questions.

Industrial hygiene procedures:

Most industrial hygienists, schooled in chemistry, testing and toxicology and reinforced by the public's "chemophobia", have challenged the importance of added fresh air and have concentrated on identifying and removing and/or containing sources of pollutants (chemicals) and routes of pollutant transmission. This focus has created an army of consultants and a very lucrative testing industry. Unfortunately, most authorities concede that the batteries of sophisticated tests and voluminous reports have been able to identify a specific cause in less that twenty percent of acknowledged sick buildings. In plain English, this means that, at the time of testing, no substance was identified that exceeded the generally accepted limits (PEL's or TLV's) for the chemicals tested. Although the presence of fungi or bacteria is commonly noted in reports, it seldom receives more than casual mention and very general recommendations. The great majority of industrial hygienists do not have formal training in microbiology or mycology and they tend to ignore or downplay the possibility of microbial causation. The above comments are not in any way meant as a criticism of industrial hygienists. It is simply a recognition of the fact that people focus on areas where they are comfortable. Faced with literally thousands of different bacteria and fungi which range from beneficial to deadly, test methods which (compared to chemical tests) have questionable reliability and reproducibility, a total lack of accepted standards, and today's fear of litigation, it is not surprising that industrial hygienists seldom venture into the complex world of microbiology.

Additional procedures:

As buildings age, the normal routines of clean-up and masking become less effective. Mold and mildew readily adapt to conventional sanitizers and biocides and many develop immunity. Also, we see clearly that certain species of fungi will find the engineered humidity and temperatures to their liking and will begin to thrive. Recognize that, as we adjust our indoor environments for the comfort of the occupants, we also create ideal habitats for a great variety of microorganisms. When this happens, major corrective actions are required. These include exterior wall sealing with breathable water repellent coatings, replacement of furnishings such as carpeting and other soft goods, and upgrading components of the HVAC system.

A Non-Traditional Solution

In 1969, researchers at Dow Corning Corporation discovered a unique way to attach biocidal agents permanently and directly to a wide variety of surfaces. The resulting non-volatile polymer is unique among antimicrobials in that it does not create a zone of inhibition and does not dissipate over time. This extraordinary technology permits the continuous, durable activity against mildew that is required to prevent infestation. Also, because the material does not lose effectiveness through absorption or dissipation, microorganisms have never been shown to develop immunity against it.

For the very first time, Dow Corning's new technology made it possible to actually control the growth and development of mildew and other microorganisms on any treated surface - even after repeated cleanings and extended use.

This unique technology, now ÆGIS Antimicrobial, has been widely used and is well reported on for its long-term effectiveness in the control of microbial contamination in indoor environments. Case histories and peer review publications show how this material, as part of a total IEQ program, provides relief and protection from indoor microbial problems.

Defensive Strategies

Dealing with pollutant problems begins in the building design stage. Environmental elements, construction materials and techniques and building systems must be integrated to minimize microbial habitats and sources for particulates and VOC's. Once commissioned and operating, proper maintenance of the air handling system, other buildings systems and structural elements is critical. At this stage of a building's life, housekeeping and space design professionals must be in concert with facilities management so that, as staffing or work functions change, appropriate air and environmental control tactics can be implemented. The simplistic "solution to pollution is dilution" mentality is out dated. A clear understanding of building use and practices plus careful selection of furnishings and operating equipment can greatly reduce pollutants in the indoor environment. There are also technological choices that make business and energy sense. Microbiological control has moved from daily cleaners and disinfectants to non-volatilizing, chemically bonded technology that durably modifies surfaces to prevent microbial growth. Proper targeting of surfaces will mitigate existing problems, greatly lower the odds of future contamination and stretch renovation schedules.

The Future

With technologies in hand, we are at the threshold where energy management principals and benefits can be merged with the immense and immediate needs for improved IEQ. We can no longer ignore the critical relationship between energy management and the indoor environment. We need greater understanding and coordinated efforts within the professions and governmental agencies charged with addressing these vital issues.

A GROWING EPIDEMIC

"Sick Building Syndrome": A comprehensive series about a growing concern to all people involved in the buildings marketplace. The purpose of this series is to explore the causes, sources, and solutions of pollutants that have been linked to many health and environmental problems.

The issue of indoor air quality is a serious problem that continues to become more prevalent everyday.

Indoor air quality is not only hazardous to our health, but also hazardous to the economic life of our businesses. Loss of building materials and furnishing, drops in productivity, increased health care costs, and even legal liability are all problems that we don't want to deal with.

These very same problems effect everyone involved in the buildings marketplace and they must be informed about concerns. People involved in this particular market must be ready to react to these problems when they happen in their own facilities — and they will happen — and they must react.

Indoor air pollution has spawned a broad array of "solutions" to the building and human problems lumped under the very misleading banner of "Sick Building Syndrome." These include real solutions from tearing out offensive materials and improving filtration/air circulation to just covering it up.

Indoor air pollution problems were magnified when the energy efficiency standards and materials used by architects and designers changed dramatically in the early 1970's. Circulation of air in an office building was reduced by 80%. With poor circulation, this literally left the door wide open to the many pollutants, bacteria, mold, and mildew that we struggle with everyday.

Working within these pollutant laden enclosed spaces, it is no wonder that many of the world's employees develop symptoms such as headaches, dizziness, burning eyes, and upper respiratory complaints just to name a few. Over time though, the severity steadily gets worse as exposure is prolonged. Reaction to indoor pollutants usually occur 1 to 2 hours after they arrive to work and last 3 to 4 hours after they get home from work.

Emotionally, however, people don't get over impairments that easy. When people are struck by an illness of any type or size, productivity starts to decrease, morale falls, and eventually your could find your company with a high turnover rate of employees. This is especially true if the cause of the illness is unknown.

Buildings themselves suffer as well. Deterioration and structural degradation are common effects of the contamination inside a building. Of course your building is not going to crumble before your own eyes, but over time occupational safety and values of buildings become issues that nobody wants to deal with legally or financially.

Anyone in the buildings marketplace must be concerned with “Sick Building Syndrome” and “Building Related Illness.” The problems are real and are costly. The symptoms may seem clear, but the causes and sources of the biological, chemical, or particulate pollutants are complex. These pollutants and their sources must be understood if protection strategies are to be taken in learning more about these problems to avoid human and building problems.

Next issue we will discuss the causes behind “Sick Building Syndrome” and how they directly relate to the most common and pervasive pollutants.

Series by Kim Strong
AEGIS Environmental (Canada) Limited

A GROWING EPIDEMIC

"Part II: "Sick Building Syndrome" (SBS) — The Causes

The causes of "Sick Building Syndrome" and "Building Related Illness" are endless. From dust to gases to microorganisms, the number of pollutants is infinite. Fortunately, there are three basic categories that we categorize the many pollutants that are a big part of our everyday lives.

The problems of SBS are serious and cause an economic impact on all people involved in the buildings marketplace. The billions of dollars of direct and indirect damage caused by indoor pollutants affect every surface, manufacturing process, piece of operating equipment, and person in a building. Asbestos, radon, lead, formaldehyde, and Legionnaire's Disease are only a few of the press-event pollutants that are present in our homes, offices, hospitals, hotels, schools and other buildings. These pollutants at high levels cause obvious and immediate effects. At low levels, symptoms start out small and gradually get worse. Human health problems range from simple irritations to deadly diseases, like cancers.

Indoor pollutants can be thought of in a rather simple way. They consist of particulates, gases, and biologicals. The diversity of each of these is great. The reality of an occupied and useful building is that these pollutants will always be present at some level. Much like weeds, many pollutants are normal until their levels or locations make them undesirable.

Particulates consist of a great variety of materials that vary in size from sub-micron to grains of sand. This matter which is transferred through the air is often small enough to be inhaled deep into the lungs, yet large enough to remain lodged once they enter. The nose, throat, and lungs filter out particles that are 1.5 microns in size (a micron is one-millionth of a meter), while particles smaller than 0.1 micron are usually exhaled. Therefore, the particles with the greatest concern are 0.1 to 1.5 microns. Asbestos, paint chips containing lead, disease-causing dust, or a fungus that stimulates an allergic response can be a serious problem. Even insecticides or rodent control treatments can cause short-term (acute) or long-term (chronic) health problems to occupants of building facilities. These join the list of second-hand smoke, industrial process source pollutants, and irritating dirt and dust from the outdoors and generated indoors by human activity, as serious health impacting indoor pollutants.

Gases are generally referred to as volatile organic compounds (VOC's) and include a wide variety of solvents, formaldehyde, and many other manmade and natural materials. They also include carbon dioxide, oxygen, nitrogen, ammonia, metallic oxides such as nitrous oxides and sulfur oxides. Ozone from machinery and formaldehyde from building materials have been recognized as "major health impacting indoor pollutants" long before today's concerns about indoor pollution came about. Formaldehyde is the most common of all VOC's. Six billion pounds are produced in the United States each year and globally this is still a major component of adhesives and insulation materials. Health effects of formaldehyde and other VOC's mimic that of a cold. If the exposure is prolonged, the health

effects generally get worse until the individual experiences such problems as chemical sensitivity, potential for an asthma attack, and other chronic health problems. Typically, indoor concentrations are 2 to 5 times higher indoors with some up to one hundred times higher.

Various insects, mites, ticks, protozoans, bacteria, and fungi are what make up the biological category. This group also includes particulates and gases as well. Biologicals interact so dramatically, directly, and destructively with buildings and their inhabitants that they have earned the right to be called the most potent of all pollutants. Even more significant, is the fact that the biologicals can be tied to all of the human responses that we associate with SBS. This is not true of the other pollutants. Non-biological pollutants, such as particulates or gases can stimulate specific human symptoms but not all of them. Besides the bacterial, fungal(mold, mildew, and yeast), and viral disease causing organisms, there are a number of these organisms that cause allergic response in sensitive individuals. Legionella bacteria, lung disease causing bacteria, E. coli, Salmonella species, and the typical skin bacteria such as Staphylococcus and Pseudomonas are all part of the biologicals found in buildings. Each of these organisms has specific life styles and habitats in buildings and are the reasons for the growing concern of occupants in today's buildings marketplace.

Particulates, gases, and biologicals represent the classes of pollutants that negatively affect people and materials in buildings. These groups are complex and are present in all areas throughout a building. The most potent of these pollutants are of course the biologicals. Knowing as much as we can about these classes, arms us with the knowledge necessary as we determine where these pollutants are and how they can be dealt with. This will be explored in the next article in this series.

Series by Kim Strong
AEGIS Environmental (Canada) Limited

A GROWING EPIDEMIC

Part III: "Sick Building Syndrome" (SBS) — Finding The Sources

The detectives stood by the side of the building shaking their heads and saying aloud — "Where do we begin?" "What do we do?" "Where do they come from?"

Human and building problems associated with indoor air pollutants are worse than ever. Modification of materials used to build, furnish, and decorate buildings and the reduction of indoor air circulation brought on by the "energy crises" in the early 1970's, were all changes that had a great impact on indoor air pollution.

When human or even building-based symptoms occur, a search for the cause must be undertaken. This can be done a number of different ways: using your colleagues' experiences, your own experiences, calling in some expert, or just plain old common sense. The easiest and cheapest way is of course, common sense. We will focus on using common sense for the discovery of pollutants in this article. Found everywhere, microbes are also particulates that produce gases. Thus making microbial contaminates the best example to look at.

By simply looking at your building, you will see areas where pollutants originate, come in, move around, and then exit. HVAC systems, windows, doors, venting systems, elevator shafts, and even people movement are pathways for pollutants. Areas where moisture is noticeable are also good indicators of possible pollutant sources. Condensation on pipes, windows, doors, water faucets, and even over-watered plants are great places for mold and mildew to grow. The biggest sources of microbial growth are fabric furnishings such as carpets, upholstery, and drapes where dirt and moisture get trapped.

Surrounding natural and human built structures greatly influence your indoor environment. Figure 1 shows some of these exterior influences. Weather patterns, nearby highways and parking garages must be counted as potential sources of your building problems. In addition, neighboring industrial factories that omit pollutants into the air must all be considered when searching for sources.

The quality of air at the point of entry must be understood and should not be taken lightly. Keeping air intakes free from dirt, standing water, and bird roosting is very important. Your air handling and conditioning system are the "lungs of your building." Therefore, by completely understanding how outside pollutants enter into your building, proper design and operation of filtration equipment can be made. See figure 2.

Once inside the HVAC system, the air is usually mixed with the recirculating building air and is heated or cooled. Mixture of this air at different temperatures creates moisture. This moisture encourages abnormal levels of microbial growth, odors, deterioration, and staining. These pollutants are then transported through the air ducts into the areas occupied by people.

This occupied space becomes a large mixing bowl of contaminated air for contact with the unknowing occupant. In an ideal system, this air would immediately be returned through vents to the outside. Unfortunately, indoor air circulation is still at a much slower rate than it used to be in the past. Therefore, before this polluted air can be recycled or vented, it is in constant direct contact with its building occupants. This reality makes it increasingly important that pollutant sources are identified, isolated, and removed.

In summary, the simple way to understand sources of pollutants is to take a broad view of the external and internal environments and check these areas for abnormalities. Also knowing the areas throughout your building where there have been "water events," should sharpen your senses to any potential sources of pollutants.

In our next issue, we will take an in depth look at and examine the worst of known pollutants — microorganisms.

Series by Kim Strong
AEGIS Environmental (Canada) Limited

A GROWING EPIDEMIC

Part IV: "Sick Building Syndrome" (SBS) — Microbial Pollutants

By far the worst known pollutants is the one that you cannot see, but they are everywhere.

In the last three articles on "Sick Building Syndrome," we have explored many causes and sources behind this growing epidemic. In this article we will explore the most potent of all the pollutants—microorganisms.

Microbes are a part of our everyday lives. They are found on all environmental surfaces, in the air and in the water associated with normal or catastrophic events. Microbes can, given certain conditions, multiply from one organism to more than one billion in just 18 hours. Unfortunately, most people think that since they cannot even see these organisms, they offer no real threat to us humans. In reality these microscopic beasts, among other factors, are being implicated as primary and contributory factors leading to an array of health concerns in the work place.

The broad spectrum of microbes are particularly potent because they can cause a full breadth of discomfort, irritation, sensitization, toxic reaction, and disease. When employees start to develop symptoms associated with "Sick Building Syndrome" they point the finger at anything or anybody. From this stems many company problems; low morale, loss of productivity and unwanted employee turnover are just a few.

Do not be panicked by the somewhat frightening array of microbial pollutants. Microorganisms fall into three basic categories: Bacteria, Fungi, and Algae. Some of these organisms only flare up as problems under very unusual conditions. Most microorganisms are at levels in buildings that do not cause problems for normal healthy individuals. Their balance is generally controlled by your operating conditions and housekeeping practices. The problem for building administrators occurs when there is an upset of this balance. In addition, the fact that 30% of the general population has some form of respiratory handicap, asthma or allergies amplifies the imbalance. As does the growing population of "immunosuppressed" people such as AIDS, organ transplant, or cancer patients. These "at-risk" people are further added to, when you include the very young and the elderly.

Bacteria, in its growing stages, usually needs lots of water. This is why Legionella spp., the causative agent for Legionnaire's Disease, is associated with showers, cooling towers, humidifiers or other water sources such as standing water near a fresh air intake. Elevated levels of endotoxins, the toxins produced my bacteria, have been measured in agriculture, the biotechnology industry, swimming pool areas, and in office buildings. The respiratory complications caused by these toxins are somewhat understood, but their real importance in "Sick Building Syndrome" events may be obscure and is yet to be determined.

Another group of microbes is Fungi. Most commonly known as bread mold or yeast, fungi are found in

all areas of a building but are most often a problem in areas that see a lot of moisture or have been significantly wet. The moisture allows these organisms to "bloom"(grow rapidly). During the rapid growth stages, these organisms give off odors, cause deterioration, and spread their irritating and allergy stimulating reproductive spores for unknowing people to encounter.

We see tremendous variation in fungal types and numbers depending on indoor surfaces, time of year, weather conditions, and even geographical area of your facility. Average temperatures, rain fall, land topography, the surrounding environment, coastal or river sited versus an inland plain, are all part of the factors that determine the types of fungal contaminants in a building. Fungi are a very common part of the outdoor air and so finding them in buildings is not a big surprise. If you smell them or if you see their characteristic stains, they are a problem and it's only a matter of time before your employees become affected.

The various fungi that occasionally receive "bad press" are generally those that are known to produce chemicals referred to as mycotoxins or aflatoxins. These chemicals are known to cause headaches, bleeding of the lungs, and cancer in agricultural workers, babies, or sick individuals that may be more susceptible than young, healthy people. Exposure routes, doses, pathogenicity and susceptibility of individuals are not fully understood but when these organisms are present they should be considered a serious concern and actions should be implemented. Stachybotrys chartarum, Aspergillus flavus, Aspergillus versicolor, and a few others are prominent in this group of fungi both because of their prevalence and their ability to be identified.

Algae, the most understudied of all microbial pollutants, are not commonly thought of as part of the microbial pollutant profile of the indoor environment. However, they can be significant. Algae found in indoor environments can cause staining and are known to have proteins that stimulate allergic response in sensitive individuals.

This review of indoor microorganisms hopefully provides an overview for those of you faced with the everyday and unusual problems caused by microorganisms in buildings. In the next issue we will examine some of the mitigation and protection strategies useful for dealing with the human and building related consequences of indoor environmental pollutant problems.

Series by Kim Strong
AEGIS Environmental (Canada) Limited

A GROWING EPIDEMIC

Part V: "Sick Building Syndrome" (SBS) — Mitigation and Prevention Strategies

The search for indoor pollutants takes us to every area in a building, to every process, and to every occupant. "We have found the enemy; now what do we do!"

Throughout this series we have identified some of the causes and sources of "Sick Building Syndrome" and "Building Related Illness." We have explored many of the infinite ways that various pollutants affect our lives. This article will provide for you 16 strategies which will help guide you to effectively controlling the overwhelming array of pollutants that are a real factor in the health of your building facilities.

As stated in previous articles, pollutant control begins with their identification, potential sources, and their pathways to unsuspecting occupants. Following these three stages, mitigation and prevention strategies can be defined and implemented. Pollutants are everywhere and the distinction between tolerable and intolerable levels is very important. Absolute control is not a practical goal. Due to this fact, the ALARA principal (As Low As Reasonably Achievable) is a commonly used and accepted guideline.

As preceding articles have discussed, bacteria, fungi, mold, mildew, yeast, and other one-celled organisms are the most potent pollutants in the indoor environment. Although microbes represent biologicals as pollutants, they are in fact representative of all of the classes of pollutants. This allows us to use these potent pollutants as an example for typical pollutant control strategies.

Depending on the pollutant, mitigation and prevention can be very difficult, time consuming, and expensive. In earlier articles we have acknowledged the importance of the full range of pollutants on the integrity of the building materials, the operating systems, the furnishings, productivity, and the health of the occupants. Knowing your building and your occupants is part of the needed defensive strategy but only part of what needs to be done to avoid occupant and "press event" problems.

The following are a few of the 16 Defensive Strategies. These strategies provide some perspective on the countless "solutions" to the SBS/BRI problem.

Architectural design of a building is critical. Everything from the climate to the relationship with other buildings must be considered. This strategy has a direct affect on the sources and pathways that pollutants take. Another area is the materials used in construction are primary sites for microbial growth and contamination. Once these materials are contaminated, remediation can be costly and very time consuming. Also the slightest swing in temperature has dramatic effects on IEQ. Therefore, heating and cooling along with humidity control should be closely monitored and kept in balance.

Other strategies include having baseline audits of your building. This way when emergencies do occur you have something to reference to. This can be a simple audit of the building materials, operating systems, furnishings, and the processes used in the building. Or, it can include actual measurement of suspect particulates, VOC's, and microorganisms. Under certain circumstances it can also be valuable to have an audit of the occupants and staff. The forms and formats for such audits are too complex for this article, but they are available from some government authorities and some service companies.

The importance of having a pollutant control contingency plan for emergency situations and a basic knowledge of your building is essential. One extremely important safeguard, that is often overlooked, is that all buildings should have a clearly written policy designed to respond to building problems. Included in this policy should be a clear scheme of response to environmental issues. Occupant complaints of temperature, air flow, lighting, noise, humidity, and the like should not only have an organized reporting system, but key response people dedicating to handling these issues. Suspected medical problems should also have clear channels for reporting and response.

Understanding the strengths and weaknesses of each strategic component is absolutely essential and often takes outside expertise. Accurate records, good common sense, compliance with regulations and standards, and involving all of the people on a prevention and solutions team will clearly help with and minimize problems associated with indoor environmental quality.

The role of microbes is paramount and their control must be a major target for anyone trying to eliminate the real and potential indoor environmental problems in our buildings. In our next article will cover the unique problems associated with the mitigation and control of microbial pollutants.

Series by Kim Strong
AEGIS Environmental (Canada) Limited

A GROWING EPIDEMIC

Part VI: "Sick Building Syndrome" (SBS) — Microbial Mitigation and Prevention Strategies

Control of the microbial pollutants in the air and on building surfaces both for today and tomorrow, is essential to the health of the building and its occupants. Unfortunately, there is not a simple, one-step solution.

This last article in our series will focus on the mitigation and prevention strategies deemed necessary in order to effectively control the most potent of all pollutants—Microorganisms. Their diversity, persistence, and prevalence allow them to live, adapt, and reproduce under a wide variety of conditions on all interior surfaces within modern buildings.

As we have pointed out in these articles, microorganisms are the most important part of the many pollutants that cause problems in the indoor environment today. Unfortunately, controlling these pollutants with traditional thinking and methods is not an easy task.

The most effective procedure for controlling and preventing microbes in your indoor environment is (1) the identification of the pollutants, (2) the determination of the sources, (3) the removal, and (4) the prevention of the pollutants. This procedure may sound simple to carry out. Unfortunately, depending on the situation and the pollutant or pollutants, remediation can become very costly and time consuming.

The identification of the problems caused and the places where the microbes exist is where controlling of these pollutants begins. ÆGIS Environmental often finds that the strategies to counter these problems revolve around the control of environmental conditions such as moisture, nutrients, and/or the surfaces that these versatile organisms need for survival and reproduction. Regrettably this does not remedy all of the problems. Only controlling the moisture or the relative humidity of the building is usually ineffective. This is due to the fact that it is inevitable that water events (e.g. flooding), broken windows, leaking pipes, human activity, or other unplanned events will occur. These unforseen events provide the excess moisture microorganisms need to bloom to population levels that are unhealthy.

One often cited strategy that must be rejected for microbial control is the "solution to pollution is dilution." This strategy of increasing the intake of outdoor air may have merit for some pollutants, but not ones that reproduce. Re-engineering the environment through moisture control, temperature control, air intake and circulation rates, new materials of construction, or new operating parameters for the HVAC system is not a reasonable alternative by itself.

Other tools must be used and these include a simple list of techniques, all of which are filled with common sense, and include: source removal or total isolation, cleaning, disinfection, and surface modification with the ÆGIS Microbe Shield Technology.

Each of these methods is filled with different risks and costs in terms of money and time. As we have stated, the use of only one method to control your microbial problem is usually ineffective on its own. The proper use of **ALL** the techniques and technologies together is absolutely essential for successfully removing and minimizing of any re-growth of organisms. It is also critical that the techniques used are appropriate with the building being treated. For example, techniques used in the treatment of a cancer hospital may be different then the techniques used in an office building. Also, techniques that you might use for a small isolated problem may not be at all appropriate for a large, wide-spread problem.

Remember, the first and best defense is a good offense. The importance of having a microbial pollutant control and prevention component as part of your contingency plan and having a baseline of knowledge about the microbial habitats in your building is essential. The usefulness of a proven long-lasting, effective antimicrobial treatment which offers protection from the re-growth of microorganisms is also essential.

We hope that this series of articles has provided you with some useful insights into the causes, effects, and solutions of indoor pollutant problems.

Series by Kim Strong
AEGIS Environmental (Canada) Limited