SICK BUILDING SYNDROME

(Text of presentation to be given to The Institute of Professional Energy Managers on 17th July 1985 by Gray Robertson, President of ACVA Atlantic Inc. The presentation will be supplemented with numerous slides.)

ACVA Atlantic Inc. was incorporated in 1981 to market the technology that the founders of ACVA helped develop whilst working with Winton Laboratories in England. The co-founders of ACVA, i.e. myself and Mr. Peter Binnie were respectively the International Technical Sales Director and the Technical Director of Winton.

Whilst at Winton, Peter Binnie and I were specifically involved in the study of internal pollution problems throughout Industry such as asbestos, heavy metals etc., in dealing with cross infection problems in hospitals and operating rooms, in identifying bacterial and fungal problems in libraries, museums, schools, medical laboratories and general offices. We developed the reputation as international trouble-shooters and have been called in to investigate numerous sick buildings throughout Europe, Scandinavia and Asia and in particular in Hong Kong, Singapore and Japan. We attributed the key reason for our success to the fact that we recognized the need to harness the diverse talents of Air Conditioning Engineers, Microbiologists and Chemists, three different disciplines unused to working together.

Since we established ACVA here in the USA in 1981 we have pioneered the same approach to problems in this Country. Our Client list now includes numerous multi-national companies in insurance, finance and banking, in health care, education, commerce and industry. We work for the Government in such areas as the Department of Health and Human Services, Customs and Excise, Coastguard, Federal Reserve Bank, Architect of the Capitol etc.

Our investigations of large buildings included any form of internal pollution of the air. This included, Carbon Dioxide and Monoxide, Organic Vapors, Formaldehyde, Radon gas, Tobacco smoke, Airborne Particulate Matter, Asbestos, Allergenic Dusts and Bacteria and Fungi. Excluding the numerous and varied cases of Asbestos fibre contamination, the one single common denominator in all the so called sick buildings that we have examined was that they were all air conditioned. This statement embraces the last 110 major buildings we have studied representing no less than 22 Million square feet of air conditioned space.

It also came as a surprise to us when we analysed our data and found:

Tobacco smoke was only implicated in approx. 5% of the buildings studied.

Organic vapors and gases including formaldehyde and radon gas contamination also occurred in less than 5% of the buildings studied.

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Tobacco smoke was only implicated in approx. 5% of the buildings studied.

Organic vapors and gases including formaldehyde and radon gas contamination also occurred in less than 5% of the buildings studied.

Generally, if we found a high concentration of tobacco smoke and/or high levels of gases and vapors, these were normally the result of poor or in some case of virtually negligible ventilation. Naturally it was also in such areas that we found higher than acceptable readings of carbon dioxide and/or monoxide.

The one certain conclusion that we arrived at was that the biggest problem by far was that air conditioning systems get internally dirty and few people realize just how dangerous this can be.

A tragic example occurred a few years ago at a Dutch Hospital where four babies had died. The Hospital had identified the infection but could not trace the source. After an investigation it was discovered that 2 birds had died inside the air conditioning ductwork. They had entered via a broken grille, became trapped and died. Bacteria from the putrefied remains multiplied rapidly in the dirty ductwork and spread to all parts of the building.

This proved conclusively that dirty air conditioning is a health hazard and can even be fatal.

There is a general misconception about air conditioning. Many believe that such systems provide filtered clean air in which the temperature and humidity have been adjusted.

In fact there is no such thing as clean air, there are only degrees of dirtiness.

Why does the air conditioning get so dirty?

There are two main reasons.

Ductwork is usually installed in the worst possible conditions, a busy, dirty and dustblown construction site. Anyone who examines the duct internals of a new home will commonly find wood shavings, plaster dust, electrical wire offcuts, lunch packets and the ubiquitous beer or coke cans. In a large building this is often magnified many fold, we have even had reports of the ducts being used as toilets during construction. Thus the ductwork often starts off dirty and it gets only dirtier with time.

Secondly, there is the dirt that is carried into the system over the life of the building. Of course most people use filters and they presume they are therefore protected. However there is no such thing as 100% filtration.

The only perfect filter would be this brick wall, this would not only stop the dirt but also the air.

These filters theoretically protected 8,000 feet of ductwork on two floors of a Philadelphia office complex. We removed 148 pounds weight of this soot, fungus and general filth from the same ductwork. So much for protective filters.

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The next thing to realize is the extent of the problem, most people are amazed by the amount of ductwork in a building. A typical 100,000 square foot building may contain between one and two miles of ductwork. The air conditioning system could be for example situated on the roof. The air it supplies is carried to every part of the building. It is pumped through the ductwork shown here in blue.

In a recent survey of a 750,000 square foot Hospital, we found approximately 14 miles of ductwork. Since all the air is constantly recycled back and forth through these ducts it is obvious that any single source of contamination inside the system can rapidly spread to other areas. The proof of this was that same Hospital, a dirt and accompanying fungal contamination in the Air Handling Chambers had been left unrecognized, that same dirt and fungus then permeated all the ductwork, result a $200,000 bill to have the system cleaned and sanitized. My Company completed that clean up, had we been involved earlier we would probably have recognized the source before it spread and a few hundred dollars would have eradicated the problem. In this area, apart from the cost savings, the risks of litigation alone strongly prove the old adage, prevention is better than the cure.

The problem with air conditioning is that it is taken for granted. It is out of sight and thus out of mind. Perhaps 90% of the system is hidden behind walls and ceilings. There is no way into the system so it cannot be cleaned, thus the dirt accumulates and where you find dirt you always find germs.

When you think about it air conditioning provides a perfect breeding ground for germs. It provides an enclosed space, constant temperature, humidity and food - which is the dirt. No germ could wish for more!

Where do these germs come from ?

First let us appreciate what we find in ductwork. Dead insects, dead birds and rodents are not uncommon. This last year we found two buildings with a dead snake inside the system. Rotting leaves and vegetation when left on the filters or in the filter chambers decompose by microbial activity, these microbes can often pass the average commercial filters. Many fungi can actually grow through the filter media and shed their spores into the ductwork system. In addition of course all soil particles carry microbes or their spores and most are theoretically harmless or even beneficial. However, present some of these spores with a nice breeding ground e.g. the condensate drain tray of the air handler and multiplication in staggering proportions occurs and even the so called harmless bugs endanger health when present in excessive numbers.

In essence it is the dirt that encourages germs to breed. Germs which cause infections. However, even in a sterile environment the dirt itself is a major problem for by definition it is household dirt and house dust is one of the most common allergens around. Ask anyone of the near 30% of us who suffers from allergies, every allergist will include household dust in the skin tests for allergies. Many of the common problems encountered in offices of dry eyes, sore throats, headaches and tiredness are caused, or the conditions are exacerbated, by such dusts being recirculated through the air conditioning.

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This Dutch article on the effects of contaminated air conditioning on office staff sums up the whole problem.

Research in Switzerland showed that absenteeism from upper respiratory infections is 20% higher in air conditioned buildings.

Now numerous press reports quote cases of colds, infections, eye irritations, hypersensitive pneumonitis etc associated with air conditioning. Even the fatal Legionnaires' Disease has been directly linked to air conditioning and this disease is far from an isolated incident. The center for disease Control in Atlanta recently estimated that there are now over 45,000 cases of Legionnaires' disease occurring annually in the United States.

Small wonder that some European Countries including Denmark, West Germany and Switzerland have introduced legislation mandating that steps must be taken to prevent these build-ups of internal pollution. This country is destined to follow that course either by slow evolution or legislation will be precipitated as a result of court actions brought by individuals or by trade unions making the building owners responsible for the health and welfare of their staff or tenants.

Apart from the unnecessary absenteeism and loss of staff efficiency, dirt in the air conditioning causes four further serious problems:

1. It is a fire hazard

   Dusts, paper and dirt in an air stream can ignite and conduct fires to other areas. Many buildings have been destroyed by duct related fires. These examples of exhaust ducts are typical of many hospitals, (these photographs were actually taken in local Hospitals) the dirt is light flammable lint from blankets and gowns etc. The slightest spark falling in these ducts will be fanned by the air and an inferno is guaranteed.

2. It wastes energy

   Accumulations in ducts increase pressure drops, contribute to blocked re-heat coils and clogged recirculation filters and of course reduce efficiency. It is not unusual to find reheat coils completely sealed with contamination as is the case of these photographs. This condition is especially prevalent when deterioration of internal insulation occurs.

3. It increases redecoration costs

   Ceiling and walls around diffuser grilles need cleaning, painting or tile replacement. Soft furnishings, carpets, drapes etc suffer excess wear.

4. It reduces system life

   Dirt absorbs moisture and increases corrosion rates. Also sulphate reducing bacteria living in the dirt can initiate severe corrosive attack especially near coils and humidifiers.

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These are alarming facts, but lets put the problem into its right perspective. Air conditioning is not dangerous as such, there are no special germs that breed exclusively in air conditioning.

THE PROBLEM IS DIRT !

AND IN PART ENERGY CONSERVATION !

And here gentlemen lets reflect on the contribution inadvertently introduced by the energy manager attempting to save fuel.

Prior to 1973 the cost of energy was such a relatively small part of the buildings operating cost that many buildings left the air conditioning running 24 hours a day, seven days a week, regardless of how many people were in the building. Now to save energy, in addition to the move to tighter buildings with sealed windows etc. some or all of the following steps are taken:

1. The air conditioning is shut off at night or at weekends. When this occurs, frequently and especially in this humid climate, condensation settles inside the ductwork, if dirt is present as this moisture reaches it spores grow and microbes flourish only to be disseminated to others areas when the unit starts up again. A frequent symptom of this is the complaint of odors or sickness on Monday mornings that disappear through the week only to reoccur the following week.

2. As fans start up or shut down vibration of the ducts often occurs and dirt deposits are shaken loose and are spread through the system.

3. Recirculation of indoor air is increased, many buildings operate with 85 - 90 % recycled air and its not unusual for us to find 100% recycled air. This condition guarantees that any infectious germs, allergenic dusts and spores etc can be carried from office to office and repeated outbreaks of "common colds" etc. move back and forth throughout the building.

4. Federal regulations dictated that thermostats should be set a few degrees higher to save energy. A couple of degrees may or may not inconvenience staff but assuredly a few higher degrees of temperature can make a substantial difference to the growth rate of bacteria and fungi aiding their spread.

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5. VAV mixing boxes and reheat boxes mounted in ceiling voids frequently have louvres opening into the void. When temperature conditions are right these louvres open and "return or exhaust" air can be introduced from the void and delivered back to the occupants in the room below. This condition allows air from the usually dirty void to return to the occupants totally by-passing the filtration system. We have positively identified fibre-glass arising from this source and causing dermatitis reactions in the staff in three different buildings within the last 12 months. Occasionally we have encountered the same design in voids insulated with asbestos. Two months ago in a Federal Building we positively identified a sickness outbreak due to allergenic fungi spread from its source in the ceiling void through such a VAV heater box.

6. Some misguided building engineers move to lower efficiency filters to reduce pressure drops in attempts to save energy. This is a short cut to potentially devastating problems later and it is a move that makes that individual liable to negligence charges in the event of future law suits.

PREVENTION AND SOLUTIONS

So much for the problems, what steps can the building owner/engineer take to minimize such problems in his building.

The main goal is to improve hygiene. The air handling systems the vehicle for all the air inhaled within the building should be routinely inspected and hygienically maintained. Part of this is simple, the air handling units should be kept as clean as is possible and filters should be chosen to give maximum protection. The highest efficiency filters possible should be used and they should be double checked to see that a correct air tight seal is maintained. If new sources of filters are chosen it is common to find substantial variations in size of "nominal" size pads, any air gaps due to this variance should be sealed with spacer bars.

The condensate trays should be sloped and the drains kept clear to allow the condensate from the coils to run away. Any stagnant water sitting in these trays will rapidly become a living stew of bacteria and fungi. Since these trays are now downstream of the filters any contamination from this source will quickly find its way into the ductwork or the fan chambers and thus into the occupied areas.

The ductwork, the biggest source, or the largest harbor, of all these problems needs special attention. Again the focus should be on prevention rather than cure and now I will demonstrate the Inspection and Monitoring steps that are now available here.

The problem of course is how does one inspect or clean an area that you cannot get into - long runs of ductwork which are largely inaccessible.

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The answer is ACVA, the unique Air Conditioning and Ventilation Access System. The ACVA system is effective, simple and economical. It is based on the ACVA Point.

The ACVA Point provides the vital access which enables Inspection, Monitoring, and if necessary, Cleaning and Sanitization of the entire air conditioning system.

The ACVA Points are placed at strategic locations along the ductwork. The Points can be fitted through false ceilings or walls directly into the ductwork. There is also an ACVA Point which is designed specifically for flexible ducts.

Once installed, the ACVA System enables us to do many things to safeguard the system itself, the quality of the building and the health of the staff and tenants:

Visual Inspection

A borescope equipped with a fibre-optic light source allows visual inspection of hidden ductwork to locate accumulations of dirt, to check obstructions, corrosive conditions and potential fire hazards. Fire dampers, turning vanes, re-heat coils, internal insulation etc can be observed improving preventive maintenance. A camera can be attached to take photographs for record purposes.

Microbial Monitoring

Germs, bacteria and fungi present within the plant and the enclosed air ducts can be monitored. Various sampling procedures enable the intruding organisms to be collected for counting and microbial analysis.

Airborne Particulates

Airborne dust levels can be counted and the particle sizes measured using electronic particle counters. Checks before and after filter banks can give practical filter efficiencies for your specific filters in your working environment.

Air Comfort Levels

The air quality with respect to air flow velocities or pressures, temperature and humidities can be accurately recorded and the data used to improve system balance.

On-going Monitoring

A continuous, low cost, monitoring service is now available based on the use of our unique ACVA SAMPLAIRES. A small number of these specially designed monitors are fitted to ACVA points in each building. Once installed a small quantity of the air passing through that section of ductwork is bled off and passed through a filter capsule. Any contaminants, dusts, fibres, microbial spores etc are trapped inside the filter cassette.

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At a pre-arranged frequency, usually quarterly or every six months, our technicians visit the site and replace the filter cassettes with new ones. Whilst on site they routinely repeat visual inspections inside the ducts with fibre-optics, examine the main air handling units, check filter efficiencies, and collect microbial samples. These samples and the filter cassettes are returned to the laboratory for examination, cultivation, analysis and evaluation. A comprehensive report is then prepared describing the tests made, the results obtained and our conclusions and recommendations.

By repeating these studies on a regular basis, the rate of deterioration of the systems can be measured. Isolated trouble spots can be identified and the problems rectified before widespread contamination can spread to other areas. Staff or tenants can be reassured that the air quality in their building is routinely monitored in the interests of their health and safety.

In our experience, the maintenance of the air handling systems dramatically improves in those building we routinely inspect. Plant engineers know that our inspectors will be around making tests and taking photographs which find their way into reports going to upper management. Units are cleaned and well painted. Filters are more carefully chosen and are well installed. These conscientious engineers are proud of the reports when they reflect on the high quality of their maintenance work.

Apart from the obvious value in collecting such air samples and data when known hazards exist such as with asbestos fibres, the educated building owner or manager is in effect taking out an insurance policy when he starts gathering data on his building. If a new, trouble free building is routinely monitored, data is generated and such data can be used to negate subsequent claims that the air quality has changed for the worse. In any event if any changes do occur management will know in advance and modifications or improvements can be made in advance to head off complaints. Furthermore, in the case of isolated complaints being brought by individuals or organized groups from these monitored buildings we at ACVA, perhaps the most experienced Company in the field of Internal Pollution will help to present managements case.

Since this presentation is titled Sick Building Syndrome I have taken the liberty to talk on the types of conditions that create such problems in the majority of cases studied. Obviously, there are numerous studies where accidents such as PCB spills etc create other problems.

Furthermore, because of time restrictions I have not described many of the rectification steps that one can take to clean or sanitize these extensive ductwork systems. Suffice to say, that by a combination of common sense, developed technology and our unique ACVA Access system we have a developed a first class record of righting any of the problems we have found. Individual ducts or even the complete systems of the very largest buildings can be cleaned and sanitized and the system returned to an as new condition in a cost effective manner.

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Apart from the obvious value in collecting such air samples and data when known hazards exist such as with asbestos fibres, the educated building owner or manager is in effect taking out an insurance policy when he starts gathering data on his building. If a new, trouble free building is routinely monitored, data is generated and such data can be used to negate subsequent claims that the air quality has changed for the worse. In any event if any changes do occur management will know in advance and modifications or improvements can be made in advance to head off complaints. Furthermore, in the case of isolated complaints being brought by individuals or organized groups from these monitored buildings we at ACVA, perhaps the most experienced Company in the field of Internal Pollution will help to present managements case.

Since this presentation is titled Sick Building Syndrome I have taken the liberty to talk on the types of conditions that create such problems in the majority of cases studied. Obviously, there are numerous studies where accidents such as PCB spills etc create other problems.

Furthermore, because of time restrictions I have not described many of the rectification steps that one can take to clean or sanitize these extensive ductwork systems. Suffice to say, that by a combination of common sense, developed technology and our unique ACVA Access system we have a developed a first class record of righting any of the problems we have found. Individual ducts or even the complete systems of the very largest buildings can be cleaned and sanitized and the system returned to an as new condition in a cost effective manner.

Finally, I appeal to all you Engineers and Energy Managers to look beyond your own field of control and beyond the constraints of your own budget. The pursuit of cost savings in a building should be a fully integrated study, unfortunately cost savings programs are usually departmentalized. A savings of 10, 20 or 30% in any one budget is usually a typical goal and when salary reviews, bonuses and even promotion is the immediate reward its hardly suprising that one can forget the effects in other areas.

For example, consider a typical 100,000 square foot office building. Based on national averages the number of people in such a building would number 667 (150 sq.ft/employee).

The typical utilities cost would range from $125,000 to $165,000, lets settle for $150,000. If the professional energy manager could achieve the remarkable goal of 33% utilities saving i.e. $50,000 per annum would everyone be happy ?

Before answering this question if any of the above mentioned energy saving steps had been implemented there is a possibility or some say even a probability of increased internal pollution. This will manifest itself as sickness, allergies, "colds", sore throats, lethargy, tiredness, etc. Another national average is that 50% of all absenteeism is due to upper respiratory infections - the common denominator in most "sick buildings".

Returning to our model building of 100,000 square feet with 667 employees, taking a most conservative average salary per employee of $15,000 per annum the total payroll cost exceeds $10 Million per annum. Thus, every 1% absenteeism costs no less than $100,000 per annum. With typical absentee rates of 4 - 8% in offices what does it profit the Company to save $50,000 in utilities if it costs several times that figure in absenteeism !

In essence, the pursuit of cost savings and the improvement in efficiency is a common goal but some fail to see the wood for the trees. Lets step back and appreciate the big picture, the impact on the Corporation not on the Department.

Please also remember that your goals and mine are not incompatible, the Hospital cited earlier in this presentation as having to spend $200,000 on cleaning up the ductwork went on to win a National Award in Energy Savings, the Engineering Director is convinced that the clean-up of the systems played a major role in his energy management program and has stated that this clean-up expense has yielded a return on his investment within the first two years and has recently asked us to commence a study of a recently required subsidiary Hospital.

Thank you for your time and for the opportunity you have given me in meeting with you today. If there are any of you interested in knowing more about our activities please pick up one of our general brochures before leaving.

Meanwhile, if there are any questions on any aspect of this presentation, the floor is yours. Thank you.

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