Sick building syndrome: An overview to raise awareness

Received (in revised form): 8th May 2009

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ABSTRACT This paper aims to explore the phenomenon of Sick Building Syndrome (SBS), which is believed to cause adverse effects in occupants of specific buildings. The major feature of SBS is that the effects experienced usually begin to disappear upon leaving the 'sick' environment. Although there is no controlling legislation for SBS, its effects have been documented, 'Sick Building Syndrome' appears in the Oxford English Dictionary, and recognised organisations, such as the Health and Safety Executive (HSE), have carried out extensive research on the syndrome. As SBS has no single specific cause, this paper seeks to identify the likely contributors, and uses a range of academic, medical, statistical and recognised organisational data to do so. The contributors include poor indoor air quality, excessive background noise, emissions from certain synthetic building and furnishing materials, inappropriate temperatures and airborne pollution. A link between SBS and inadequate levels of maintenance is suggested. This paper offers information to those engaged in the design and maintenance of buildings, while giving specific advice to both employers and employees, especially those who work in office environments, to provide the reader with a better understanding and to highlight the measures that can be taken to reduce, if not eliminate, SBS.

Journal of Building Appraisal (2009) 5, 55–66. doi:10.1057/jba.2009.20

Keywords: sick building syndrome; SBS; poor health; indoor air quality; inadequate ventilation; office illness

INTRODUCTION

'Sick Building Syndrome' (SBS) is a term that has been used over recent decades. It is used to describe a range of non-specific illnesses that are experienced by an occupant while inside a particular building or within a specific area of the inside environment. The symptoms experienced usually disappear hours, or in some cases days, after the occupant is away from the enclosed environment.

Extensive research has been carried out over recent years to determine the exact science behind the syndrome, and many leading authorities, such as the Health and Safety Executive (HSE), Building Research Establishment (BRE) and National Health

Service (NHS), have addressed this issue, although it has not been directly referred to under legislation.

The syndrome has received a degree of publicity, with Prince Charles specifically commenting on SBS and blaming it, along with poor urban planning, on contributing to social and health problems. It was reported that the Prince of Wales told delegates at a London environment conference that

We are beginning to see that when we build badly, it doesn't only affect the health of the natural environment, it affects our own health as well. (Building Magazine, 2005)

Despite this media coverage, the syndrome's existence is still unknown in many workplaces. Many employers may be unaware of its existence, and furthermore, of what can be done to help remedy it.

WHAT IS SICK BUILDING SYNDROME?

The Oxford English Dictionary defines SBS as follows:

Sick building syndrome *n.* a syndrome of uncertain aetiology consisting of non-specific, mild upper respiratory symptoms (stuffy nose, itchy eyes, sore throat), headache and fatigue, experienced by occupants of 'sick buildings'; (also) the environmental conditions existing in such a building; abbreviated SBS. (Oxford English Dictionary (OED), 1989)

Further to this, SBS is a term that has been assigned to a number of ailments that people experience while occupying a building that then disappear hours or days after the person leaves the building.

SBS relates to non-specific illnesses, and an HSE report states that it can be 'discriminated from other building-related problems such as physical discomfort, infections and long-term cumulative chemical hazards such as asbestos and radon' (HSE, 1992).

THE HISTORY OF SBS

The HSE states that the issue of SBS was first reported during the 1960s, yet it was not until the 1980s that further reports began to be published, raising awareness of this newfound 'common' problem (HSE, 1992).

It was in the 1970s that the term SBS became more common because of the effects of this newfound syndrome being experienced by more and more people, leading to increased reporting and investigation being carried out.

It is believed (Murphy, 2006) that the reasons for buildings becoming 'sick' throughout the 1970s stemmed from the drive for energy efficiency, which led to the following sequence of events.

The 1970s 'energy crunch' drove all buildings to become energy efficient because of the rise in energy prices. This then led to architectural techniques being focused on designing buildings, such as offices, to be 'air-tight', thus providing reduced thermal loss within the structure and being more energy efficient (Figure 1).

As a result of this sealed envelope design, new constructions required a form of comfort control climate system to be installed, allowing ventilation and air circulation into and around the floor plan. To assist this air circulation, 'open plan' floor-by-floor layouts were used to maximise the use of the installed mechanical ventilation system (Figure 2).

Figure 1: A typical 1970s construction. Located in a busy city centre, surrounded on all sides by roads and in close proximity to bus stations and car parks. The building has been made 'air-tight' by sealing the windows, but has unintended openings in the envelope fabric.

Figure 2: An 'open plan' office space with mechanical ventilation installed throughout. Lack of attention to the space planning, via inappropriate configuration of the desk layouts, and maintenance of the ventilation system can lead to overall poor indoor air quality and ineffective air circulation.

In addition to this sealed, mechanically ventilated environment was the installation of relatively 'new' synthetic materials that were becoming available to designers.

Materials such as plastics, solvents, adhesives, synthetic carpets, particle board, dry wall, acoustic tiles, and so on made up the surfaces that in turn housed computers, printers and fax machines that were mechanically kept cool and dry. (Murphy, 2006)

These products are thought to emit volatile organic chemicals (VOCs), and these materials combined with a sealed, mechanically ventilated open floor plan contributed to the increase in the causes believed to be related to SBS.

WHERE CAN SICK BUILDING SYNDROME OCCUR?

The characteristics associated with the syndrome can occur in any construction where the conditions exist. The presence of SBS has mainly been recorded in post-war sealed buildings that share the following common influencing characteristics:

- are mechanically ventilated;
- have poor and ineffective layouts;
- have poor or no active maintenance arrangements in place; and
- have inappropriate furnishings and building fabric.

WHEN IS A BUILDING CLASSED AS ‘SICK’?

The ‘American Standards for Heating, Refrigeration and Air-Conditioning Engineers’ (ASHRAE) states that a building is ‘sick’ when ‘20 per cent or more of its occupants voluntarily complain of discomfort symptoms for periods exceeding two weeks and affected occupants observe rapid relief away from the building’ (Environmental Analytics L.L.C., 2009).

OTHER WORKPLACE-RELATED ILLNESSES

Jack Rostron, who has carried out much work on SBS, stated that there are four main types of illness within the workplace (Rostron, 1998).

It is important that these terms do not get confused in the process of identifying the problems that may be present onsite and in choosing an appropriate, effective path to take in remedying the situation.

These illnesses are as follows:

1. Sick Building Syndrome (SBS) (as discussed in this paper).

2. Building-Related Illness (BRI)

BRI is a condition that has known specific symptoms and also a known origin, examples being humidifier fever and Legionnaires disease.

These disorders are not associated with psychosocial conditions, that is, gender- or work-related stress. They do not involve building components such as lighting as influencing factors.

The source of BRI can be found through an investigation into the physical aspects of the building and the spread of symptoms.

3. Mass Psychogenic Illness (MPI)

MPI occurs when a large number of people are affected or are believed to be affected by a set of symptoms, but without an identifiable infectious agent. MPI shares common characteristics with all the other workplace illnesses.

MPI is most likely to occur as a result of psychological factors, rather than a specific disease. People who are affected by MPI tend to experience high stress and tension within the environment in which they work.

The main difference between MPI and SBS is that the effects and symptoms of the condition are not alleviated when the person(s) affected leaves the building, and the spread of this ‘illness’ is through social networks, rather than building area/type.

4. Neurotoxic Disorder (NTD)

NTD affects people within a building when neurotoxic substances such as heavy metals are present.

The symptoms associated with this disorder include mood changes, motor and mental slowing, and memory and concentration problems.

NTD is different from SBS (and BRI) because of both physical and physiological distinctive changes experienced by occupants, although it may produce similar psychological reactions to SBS.

THE CAUSES OF SICK BUILDING SYNDROME

The NHS states that research on the cause of SBS has been ongoing since the 1970s, but no single cause has been identified.

The cause of SBS is usually directed to several factors that work in combination and build up to a point at which people within the area start to be physically affected. The main cause of SBS is believed to be related to the quality and effectiveness of the internal ventilation system. The main contributors to SBS include the following.

Inadequate ventilation/poor indoor air quality

Poor ventilation rates and ineffective circulation of air is held as the main cause of SBS. Air conditioning units and the pollution within the atmosphere from both inside and outside the building are believed to be the main contributors. This pollution is then circulated around the build, which has a negative effect on the Indoor Air Quality (IAQ), because of high numbers of air contaminants such as gases like CO, CO₂, VOCs and particulates.

Motivating this theory is the fact that when 'energy efficient' offices were constructed from 1973 onwards, the amount of outdoor ventilation per individual occupant was set at five cubic feet per minute (cfm). This amount was considered in many cases to be highly inadequate for maintaining a healthy and comfortable working environment. It was not until the mid-1990s that the American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) revised the amount per occupant to 15 cfm, this being raised to 20 cfm for offices and up to 60 cfm (minimum) for areas of specific use where heavy pollution may accumulate, or is produced (Bialous and Glantz, 2002).

This additional ventilation rate may help to reduce the number of complaints regarding indoor air quality, and this has not yet been proven, although the Chartered Institution of Building Services Engineers states that

... SBS is not linked to the type of ventilation or air conditioning system used but is more likely to be a function of how well systems are installed, managed and operated ... Workspaces conforming to CIBSE guidelines on temperature and air movement should not suffer SBS, unless there are aggravating work related factors or extreme levels of pollution. (Armstrong, 2001)

Volatile organic compounds (VOCs)

VOCs are carbon-based (organic) compounds that have a high vapour and low water solubility, and therefore evaporate at ambient temperatures within a building. These compounds come from a range of indoor sources such as photocopiers, printers and cleaning supplies.

VOCs cause damage to the human body in a variety of ways, ranging from headaches and fatigue to shortness of breath, when exposed to significant levels.

Experts estimate that the VOC levels of indoor air sometimes reach 100 times those of outside air (All Business, 1990).

Figure 3: A section of drywall in disrepair. This breakdown of building fabric can result in Volatile Organic Compounds (VOCs) being released within the internal atmosphere.

Internal sources of pollution

Internal sources of pollution mainly consist of the synthetic materials within furnishings and the fabric of the building that may release volatile organic contaminants (VOCs). The use of mechanical devices such as computers and fax/copy machines can give off emissions and heat that can increase the contamination levels within (Figure 3).

Poor maintenance and inappropriate cleaning methods can release chemicals from cleaning agents into the environment, further compounding the situation.

External sources of pollution

External emissions such as car exhaust fumes and other industrial pollutants add to the poor indoor air quality, as they gain entry via intended and non-intended openings within the building fabric (Figure 4).

Although buildings are initially designed to be airtight, non-intended openings, either from poor design/construction or from disrepair over the years, or intended openings in the building envelope such as windows, allow pollution from outside the building to enter, collect and then circulate around the occupants (Figure 5).

Temperature and humidity

An environment that is either too hot or too cold causes a physical reaction for occupants. This response can have a greater effect on staff who may be more susceptible to either extreme temperature, further adding to distress on the human body.

Dry, airless conditions are common within sealed buildings, the result of this being coughing, a sore throat and, in some cases, increased risk of dehydration, thus leading to both physical and mental negative effects.

Noise

Noise levels within the building can add further stress to occupants, whether the noise is of a low or high level, constant or intermittent, and so on. In offices, it is common for low-level background noise and the high-pitched ringing of telephones to be present; this noise pollution is widespread in offices that have 'open plan' layouts.

Figure 4: Close proximity car parking. External pollutants from vehicles and inner city factories contribute to the internal environment via intended openings such as windows or, as in this case, unintended openings such as those created by disrepair of the building envelope.

Figure 5: Vegetation entering the building via window sills. This plant life shows, and may possibly be the cause of, a breakdown of the building fabric, resulting in external pollutants being allowed to enter and contaminate the internal atmosphere.

Figure 6: Types of problems found in 2003 Indoor Air Quality (IAQ) investigations.
Source: The National Institute for Occupational Safety and Health (NIOSH) 1984.

Poor or inadequate lighting

A significant lack of natural daylight or mechanical lighting that is flickering, too bright, too dull and/or does not emit the right type of light for the surrounding working conditions can cause discomfort to users in the immediate vicinity.

Psychological factors

Job factors such as stress and anxiety resulting from the working position, especially when computers are used at a workstation for long periods of time, and pressures of meeting work criteria can also contribute to the causes of SBS (*Compiled from The Environmental Illness Resource The Environmental Illness Resource (EIR), 2007*).

Indoor air quality investigations

Investigations carried out by the National Institute for Occupational Safety and Health (NIOSH) into the air quality of buildings with air conditioning equipment show what problems are found in enclosed buildings (Figure 6; London Hazards Centre, 1984).

The investigations conducted show that the greatest problem by far comes from the air circulation and quality in and around the building; these are factors that can be controlled and managed by the employer with adequate management plans.

THE EFFECTS OF SICK BUILDING SYNDROME

The occupants of a building who are 'sick' may suffer from a number of non-specific, unrelated symptoms. Attempts have been made by a number of organisations and authorities to try and distinguish these symptoms and to classify them into categories, that is, chemical- or microbe-related, but these distinctions have not been officially stated.

Rostron (1998) splits the symptoms of SBS into the following five general categories:

1. 'Mucus Membrane Irritation – usually affecting the eyes, nose and throat': A blocked or 'stuffy' nose is the most common complaint in sick buildings, with sneezing and

running of nose being far less common. Throat irritation, dry coughs and increased thirst may also occur. This can cause more problems to users who are more susceptible to the effects, that is, problems for people who wear contact lens.

2. 'Neuropsychiatric disturbances, such as fatigue, headache, confusion and dizziness': Headaches experienced are described as a typical dull pressure on the head, and do not usually develop into migraines or throbbing headaches.
3. 'Skin disorders, for example itchiness, dryness and rashes': These symptoms are the most difficult to relate to SBS because they occur over a prolonged period of time and could easily be related to other factors or medical conditions.
4. 'Asthma-like symptoms, such as tight chest and difficulties in breathing': Poor indoor air quality with a high number of airborne particulates can cause issues for occupants in good health. They can also trigger and exacerbate existing problems that people with medical conditions may suffer from.
5. 'Unpleasant odour and taste sensations': Emissions from products and equipment used within the enclosed environment can be unpleasant for occupants and may lead to nausea.

Other reports state that there may be up to 50 symptoms in total, which may occur and be totally ignored, or may add to common problems (Wikipedia, 2007).

WHO CAN BE AFFECTED BY THE SYNDROME?

SBS does not discriminate; it can affect anyone who occupies the area/building.

Employers need to be alert to the signs of SBS, even if these symptoms do not affect everyone in the building/area and not all occupants outwardly 'suffer' the effects.

A study by Lars Molhave (Baechler, 1991) states that the effects of SBS may be seen as a result of a range of protective reflexes by the human body, triggered by the types of environment that are occupied, and further suggests that human response may be related to a biological model consisting of three stages:

- Sensory perception of the environment – The senses include odour, taste and chemical sense. The chemical sense refers to the nerves on the skin and in the mucousal membranes (nose and mouth) that react to chemical stimuli. Activation of the senses leads to irritation and possibly a protective response, such as sneezing.
- Weak inflammatory reactions – Inflammatory reactions are related to microbiologic, metabolic or immune system reactions, and are generally considered to be a protective reaction to potential cell damage. Acute, reversible reactions seem to be relevant to low-level pollutant exposure in non-industrial environments such as offices.
- Environmental stress reactions – The constant effort needed to identify wanted and to override unwanted sensory information, and the efforts needed to maintain protective reflexes may cause secondary effects, such as headaches.

WHAT CAN BE DONE?

In conclusion, SBS can occur for a number of reasons, and its effects can lead to poor health of occupants, especially in those with existing medical conditions. The employer has a duty of care to remedy the causes of SBS; the following measures outline what actions/strategy can be taken and identifies the employer's responsibilities.

The preventive approach

The most effective way to eliminate SBS in a new building is for the design team to factor out the aspects associated with the cause.

In today's current energy-conscious climate, the need for energy efficiency is greater than ever, highlighted by the changes made to Building Regulations – Part L: Conservation of fuel and power, 2006.

The design team must ensure that an energy-efficient building is constructed, and close liaison among the Space Manager, Mechanical and Electrical (M+E) Engineer, Designer (and/or Interior Designer), Maintenance Manager and Project Manager is needed in the planning stage to eliminate the risk of building SBS factors into the construction. Consideration is required regarding the type of building materials used, and fittings and furnishings installed, so that VOC emissions are limited if not totally avoided and high amounts of light are not reflected from the surfaces of desks.

Any mechanical ventilation systems need to be designed not only in compliance with Building Regulations and Chartered Institute of Building Service Engineers (CIBSE) guidelines, but detailed consideration should also be given to the intended layout and building shape to ensure efficiency of the system. Therefore, all plans, drawings, layouts and intended uses must be agreed upon and made available for the M+E Engineer to work from.

Any known change of use that may occur in the future should also be noted, so that provision can be made to allow alteration/expansion of the system, thus future-proofing the installation and further preventing ineffective ventilation rates.

Open plan layouts are very common, and are a preferred option in modern day offices. The location of people should be planned accordingly, so that people are positioned where natural light can enter the building and away from any sources of disruptive noise. The positioning of people and equipment should be in direct relation to the location of the ventilation systems' circulation flow.

Management systems and maintenance schedules will help greatly to ensure that a safe and healthy environment is achieved. Planning of maintenance is required at an early stage to allow the appropriate cleaning facilities to be provided and allowances made in funding to carry out essential cleaning of the building, regular maintenance of ventilation systems and reactive maintenance/repair to the building fabric, furnishings or mechanical systems.

The reactive approach

The systematic approach is the best approach to eliminating SBS from existing constructions, and entails identification, carrying out remedial work, monitoring and reviewing. The HSE offers guidance, and outlines what actions can be taken to assess the presence of SBS and what action employers can take.

Employers can identify the presence of SBS by producing simple questionnaires asking staff about any symptoms that they feel they experience and any issues that they may have with the building or area in which they work. External assistance may be required to produce guidance if the employer suspects that SBS is affecting large numbers of the building occupants.

The possible causes of SBS need to be identified and addressed appropriately, that is, ventilation systems need to be cleaned and furnishings replaced where possible. Other simple steps can be taken to reduce the risk of SBS becoming a problem in existing areas, such as opening windows to allow more natural ventilation into the building while reducing the internal temperature and repairs to the building fabric, to prevent unwanted pollutants from entering.

When areas of the building are refurbished, it is important that debris, dust and the release of other airborne particles are controlled. Where new materials are to be used, these materials must be specified to reduce, if not totally remove, the risk of VOCs being released.

Active management of a building's maintenance is the most effective way to prevent SBS becoming an issue in the future, that is, checking that filters on mechanical and electrical equipment are clean and replaced when used up, and that materials are being properly stored.

After the remedial measures have been carried out, the building environment and its occupants need to be monitored to evaluate the effectiveness of the actions taken and to give early warning if symptoms begin to reappear. Management systems and the maintenance schedule also need to be monitored to ensure that they are being followed properly.

Training of building occupants can be a useful tool in the prevention of SBS. A range of training sessions addressing how influencing factors of SBS can be controlled would help to raise awareness and encourage occupants to be proactive in the reduction of pollutants, that is, not using aerosol sprays inside the building.

The whole process should then be reviewed by the employer on a regular basis to help to identify any areas that still require improvement or may become problematic in the future.

EMPLOYER'S RESPONSIBILITIES

Although the syndrome is not specifically covered/highlighted under specific legislation, employers should be aware that they have responsibilities under the following legislation to prevent and reduce the causes associated with SBS (Unison, 2004).

Health and safety at work act 1974

The employer has a duty to provide and maintain a healthy and safe workplace. If SBS is suspected within the workplace, the employer must carry out investigations to identify the source of the problem or to prove that SBS is not present. The employer must also be aware that even if the pollutant levels are below the legal maximum, if these are found to be causing problems to employees' health, steps must still be taken to remove/reduce them.

Management of health and safety at work regulations, 1999

Management of health and safety within a workplace should be achieved by the use of risk assessments. If SBS is suspected or proven within a building, it must be included in the risk assessment, which needs to state what measures are required to lower the risk.

Workplace health, safety and welfare regulations, 1992

The workplace regulations state the (minimum) standards of the workplace environment, including areas such as ventilation and temperature, lighting, cleanliness, and dimensions of room/circulation space.

These standards offer guidance, and state what measures must be adhered to with regard to the minimum requirement for checking legal limits. These standards, however, offer restricted use because of certain aspects, for example, no maximum temperature at work, have no legal limit.

SUMMARY

SBS is an issue that can affect any workplace or building regardless of its use. There is no set model to identify SBS either in the cause or effect of the syndrome, and this is because of a combination of different factors that need to be present within the building for occupants to experience symptoms.

The distinguishing feature of SBS is that it follows a regular pattern of symptoms that appear after the first few hours of entering a potentially 'sick' building, and these symptoms start to dissipate within minutes after leaving the premises, although they could potentially take days to subside in extreme cases.

In working environments, employers have a duty of care to promote, achieve and maintain a safe and healthy working environment for their staff. Therefore, employers should be alert to, and make staff aware of, the factors that can lead to SBS, so that issues can be remedied or prevented before they have an adverse effect on employee health, which may lead to high staff turnover, and have a negative impact on work output.

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