

## **SICK-BUILDING SYNDROME**

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**Abstract.** In the present article we study, from theoretical point of view, the sick-building syndrome (SBS). We analyse more than 50 symptoms that are reported by those who suffer from the SBS. In addition, the most important factors that lead to the development of SBS are distinguished and we mention the substances that generally seem to cause SBS. Moreover, a model about the prediction and ascertainment of SBS has been proposed. Finally, overall rules for prevention and confrontation of this problem are suggested.

*Keywords:* sick-building syndrome, symptoms, indoor environmental quality, workplace environment, health hazard evaluations.

## **AIMS AND BACKGROUND**

The modern person spends more than the 90% of his time in buildings. A very big percentage of workers in the public or private sector work in big office-buildings, which most of the time have a central heating and cooling system, and windows that remain sealed. In these office-buildings various materials are used for the formation of internal spaces such as wallpapers and carpets, as well as equipment like computer screens, printers, and photocopiers. The lighting is quite bad since

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flickering neon lights are used. In addition, various chemical products are used for the cleanness and the maintenance of the offices. All these create conditions that devaluate the quality of the internal environment and more generally 'internal climate' of the buildings, with important repercussions on the physical and mental health of workers<sup>1-3</sup>. It should be noted at this point that similar problems might also arise in homes as well<sup>4,5</sup>.

#### WHAT IS SICK-BUILDING SYNDROME?

The spectrum of symptoms on the health of the individual that are related to his/her stay in a building, which has a downgraded internal environment quality, is named sick-building syndrome (for reasons of brevity we will henceforth use the internationally established English acronym SBS). Therefore, the term SBS is conventionally used, in order to describe all those situations where the individual feels various symptoms or a general intolerance and malaise and has no concrete and identified illness that describes these symptoms. The term SBS creates queries and question marks. Is the building 'sick'? is in contradistinction to is it 'healthy'?; Can this 'illness' be transmitted from a building to another? It is obvious therefore, that the term SBS is conceptually relatively infelicitous, however it has prevailed internationally and is used widely by all that refer to this certain problem. The SBS should not be confused with contagious illnesses or poisonings that are caused by concrete causes, e.g. the illness of legionaries, poisoning by carbon monoxide, etc. It is a wide spectrum of symptoms and discomforts that do not have an identified cause and the individual that suffers from these symptoms complains for discomfort as long as he/she is in the building, while these symptoms cease to exist once the person exits the building, even for a very short time.

There are more than 50 symptoms that are reported by those who suffer from the SBS. It is likely that many of the tenants of a building may report symptoms that are not connected with each other and thus be overlooked or not attributed to the SBS. The usual symptoms, as they have been described by the World Health Organisation<sup>6,7</sup> are: changes in personality, nervousness, anger, perspiration, depression; headaches; nausea and light-dizziness; fatigue, lethargy; difficulty of concentration; high frequency of infections of the respiratory system and cough; hoarseness and dyspnoea; symptoms of asthma in non-asthmatic; rheum and allergic rhinitis; irritation of the eyes, the nose and the larynx; sensitivity of the mucous and the skin; erythema, red blotches; itching and inexplicable hypersensitivity.

These symptoms are in most cases mild; however, they can negatively influence the individual in his work and more generally the level of his well-being, thus having important consequences in his productivity but also in his quality of life.

As it was already mentioned, if there is an important number of workers in a building that often complain of some of these symptoms and if these symptoms disappear when leaving the building, then we have SBS<sup>8</sup>. However, it should be

mentioned that this is not a safe factor for the detection SBS, since many of these symptoms can persist in some individuals and disappear in others. In addition, there are long-lasting implications that have not been sufficiently researched and should not be overlooked especially in cases of oversensitive individuals.

## DISCUSSION

*Reasons and factors that cause SBS.* Up until today, even though there have been many studies and research<sup>1,2,9,10</sup> no proof has been given that certain concrete reasons can cause SBS. However, it appears that there are certain factors which aggravate the appearance of SBS, either they are applied alone or in combination with other factors<sup>11</sup>. The most important factors for the development of SBS are distinguished below:

- insufficient ventilation;
- high temperature and lack of air circulation;
- low or high humidity;
- poor lighting, especially during the day;
- airborne chemical pollution;
- airborne organic matter from the air conditioning system;
- low moral and general lack of satisfaction from work and the work environment;

- poor office ergonomics.

The substances that generally seem to cause SBS as follows:

– Biological factors of pollution are usually the most incriminating factors for the development of SBS. They mainly include the following:

- toxic black mould emanating from excessive humidity;
- akarea that flourish in rejected human cells and are found in the carpets in the furniture covers and in beds, etc.;

• pollen from trees and plants that are transferred in the building by multiple ways, e.g. shoes, domestic animals particles of dead insects, particularly cockroaches;

• bacteria, fungus and other microorganisms that may be harmful to the health of people can be accumulated in buildings under suitable conditions for their growth, in water pipes, in air conditions, etc.

– Carbon dioxide can be found in the atmosphere in low concentrations of approximately 0.03%. However, the air exhaled contains about 5% carbon dioxide; therefore, in rooms with many people that are not ventilated properly high levels of carbon dioxide are inevitable. In big concentrations carbon dioxide causes headaches, lethargy, and difficulty in breathing and seeing.

– Carbon monoxide is produced by combustion. The most important source of its release is the evaporations of vehicles, but it also exists in the smoke of

cigarettes and liquid gas or oil radiators. It deprives oxygen from the brain and in the initial stages of poisoning it causes headaches and dizziness, while in higher levels of concentration it causes vomiting, fainting and death. A long display to gas even in relatively low concentration levels related with cardiac problems.

– Oxides of nitrogen. As in carbon monoxide, nitrogen dioxide can be produced from combustions, evaporations, smoke from cigarettes and central heating. It causes irritation of the respiratory system and the eyes.

– Sulphur oxides are released from various combustions as in fireplaces, in heating systems that use coal, etc. In combination with other substances they can cause damage to the lungs, bronchitis and carcinogenesis.

– Formaldehyde is an element of many products, such as insulating materials, furred ceiling plates, plywood, office furniture, carpet glue, synthetic carpet fibre, various plastics, pesticides and insecticides, colours, etc. The levels of release increase with temperature. It is a colourless gas with an acid smell. At a 2–3 ppm it irritates the eyes, the nose and the larynx. At a 4–5 ppm it causes nausea, trouble in concentration, memory loss and skin rashes. At a 10–20 ppm it causes great difficulty in breathing and serious burning in the eyes, nose and throat.

– Ozone is a natural component of the atmosphere; however it can be released from certain appliances such as photocopying machines or electrostatic cleansing filters for dust. Ozone can cause genetic abnormalities, as well as headaches, dizziness, fainting, and in great concentrations it can damage the lungs.

– Hydrocarbons are found in several synthetic materials, colours, floor detergents and furniture, etc. They affect the respiratory system, the eyes and the skin; they can cause nausea, headaches, damage the central nervous system, the kidneys and also cancers.

– Benzene is found in synthetic fibers and plastic, in cleaning liquids and in the smoke of cigarettes. It can cause cancer and damage to the central nervous system, the skin and respiratory system.

– Ammonia is found in various cleaning products, in the ink used for printers and in the smoke of cigarettes. It influences the eyes and the respiratory system.

– Heavy metals do not constitute any special danger, since their presence in buildings is limited due to legislative regulations that forbid their use. However, in older buildings they might be a problem especially from lead and mercury that was used in painting colours.

– Mantle is a particularly dangerous material that was used in a lot in buildings that were built in decades 1960 and 1970. Its use as insulating material was wide and with time it was inevitable that fibres of mantle transported in air of the building. Today it is not used, while buildings that have mantle have it removed. It causes cancers and fibrosis of lungs.

– Insecticides and pesticides can cause serious damage in the respiratory system, the nervous system, the eyes, the skin, etc. Their use even in the evening or in

the weekend can be harmful if proper ventilation is not made before the workers enter the building. Some preservatives of wooden furniture can release substances in the atmosphere for many years.

– Cigarette smoke contains hundreds damaging substances that cause a big variety of damages to the organism of the smoker but also to the passive smokers.

– Radon is a by-product of uranium that is found in the soil in various concentrations. It is also found in the concrete or in the stones that are used in the manufacture of buildings. It causes cancers and damage in the reproductive system.

– Solvents. Turpentine, acetone and other solvents can cause damage to the eyes, the skin, the respiratory system, but also may cause liver and lung cancer. Solvents exist also in various glues, cleaning liquids, etc.

– Computer screens and electromagnetic radiation. Working in front of computer screens that emit a low frequency of electromagnetic radiation has multiple effects to health. Headaches, drowsiness, pain in the eyes, increased sensitivity to respiratory diseases, problems in the circulation, abnormalities in the period, expulsions and damage of the foetus and many other problems have been reported. Working on computers is particularly prohibited to pregnant women. These problems can be more intense to people working around computers because certain screens emit more radiation from the back or the side rather than the front part.

– Stress. It is obvious that there are tones of things in a building that under certain circumstances can cause SBS. The inability of people to control their working conditions causes great stress. If one is unable to control temperature, humidity, the rhythm of ventilation, the volume of sounds, the lighting, the smoking and other factors, while at the same time there are problems from various materials used in the building, then the level of stress is high and the effect on productivity and on the individual health is also serious.

– Quality of air and regulation of temperature. A comfortable and clean labour environment presupposes that there are no big variations of temperature, there are no smells, dryness of air, etc. The regulation of temperature, humidity and the circulation of air in the buildings are the three most important factors for the creation of correct internal environment. These factors work with each other, while different people have different levels in which they feel 'comfortable'. As an example, women usually like the temperature to be a little higher than men. In general terms there are certain specifications, as those, for instance, of the American Union of Civil Engineers<sup>3</sup>:

- temperature at 19–23°C;
- relative humidity of 40–70%. Higher than 55% relative humidity is needed when the building has carpets or the heating is from the floor. If the relative humidity is very low then we have dryness of the mucous in the nose and larynx, while if the relative humidity is very high then breathing is very hard;

- the flow of fresh air should be a minimum of 8 l per individual, while when there is a smoker in the room 16–25 l of air are required depending the quantity of smoking;
- speed of air must be at 0.1–0.3 m/s. Slower speed causes stuffiness, while faster speed causes a current;
- sound must not exceed 46 dB. A low but continuous noise can also create problems;
- lighting must be at 500 or at 750 lux for people that work on drawing boards, or have to read literature. Fluorescence lamps must be avoided.

*Detection and ascertainment of SBS, prevention and confrontation.* When workers are diagnosed with symptoms of the SBS, then the undertaking of certain measures and initiatives, that will face the situation, is required. However, there are many examples from bibliography where the actions that were undertaken were fragmentary or not completed and thus the problem remained. At the same time, plenty of money was spent pointlessly. It is therefore explicit that a more systematic approach is required, in order to detect and to ascertain the precise factors that create the problem and afterwards to give the correct solution. The line of action can be as follows:

- distribution of information on the SBS to workers;
- realisation of research with a suitable questionnaire for the precise measurement of various symptoms and the imprinting of the opinion of workers for the conditions of their work- place;
- complete and in detail optical inspection of the building;
- concentration of technical information on the layout of the building, the ventilation system, the heating, the air conditioning, etc.;
- record all the required actions and changes that will bring concrete improvements;
- realisation of research after the changes are made and evaluation of measures taken.

It is obvious that the actions undertaken are related with the results given by research, both for workers and the building. Many times, however, it is very difficult to find concrete factors. For example, the measurement of a certain factor with some instrument may at that specific point give results that are within certain safety limits. However, these levels can often change, or the aggravating factor can cause damage because of its long-lasting exposure to individuals. Thus, to simply measure with certain instruments or to make an optical surveillance of building, is not enough. There might have to be and should have to be repeated measuring. In general the process of detection and identification of the problem requires plenty of time.

## CONCLUSIONS

It is of no doubt that a comfortable labour environment contributes in the mental and physical health of workers and in the rise of productivity. As a consequence, it is the responsibility of the state to adopt measures and laws that will protect the workers and will ensure a comfortable and healthy working environment. It is also clear that it is also a question of responsibility of the administration of an enterprise or an organism to see that factors that cause or are related to the SBS do not exist in their enterprise or organism.

In many cases the solutions and the measures that must be taken are quite costly and the administration of the company or organism may be negatively predisposed. The workers should know that within the legislation exist henceforth enough forecasts with regard to the terms of hygiene and safety in the work place and in many cases the SBS is mentioned. As an example, it is prohibited to use mantle, pregnant women to work on computers, etc. It is consequently an inalienable right of workers to require the application of legislation. From another point of view, in many cases the cost of the measures that are required for the improvement of the working conditions is much smaller than the cost that the enterprise or the organism will have when many hours are lost due to decreased productivity.

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*Received 2 June 2008*

*Revised 15 July 2008*