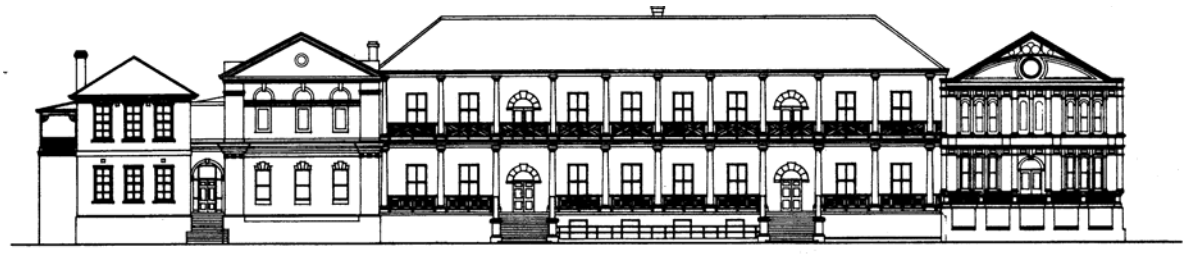
LEGISLATIVE ASSEMBLY

STANDING COMMITTEE ON PUBLIC WORKS

Report

SICK BUILDING SYNDROME



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FOREWORD

Technology has, this century, enabled us to cut ourselves off from the physical environment in which we have long existed. As a consequence we have, more and more, seen buildings designed in such a way as to completely separate occupants from the external environment.

This initially occurred for apparently sound reasons. People sought protection and relief from extremes of hot and cold climates while at the same time pollution levels in the outside environment were rightly seen as causing health problems.

Yet it seems that this cocooning has brought about its own set of problems. Evidence is now mounting that this artificially created environment is bad for our health and bad for the economy. Many experts are beginning to question this artificial separation, particularly in relatively mild climates and particularly where considerable advances have been made in cleaning up external air pollution.

Given the link between these emerging indoor pollution problems and the provision of building infrastructure, the Committee decided to look at one of the health problems associated with the indoor environment by inquiring into Sick Building Syndrome.

This is an inquiry tailor-made for the NSW Public Works Committee with its charter to review matters relating to public sector infrastructure provision as well as the environmental impacts of that infrastructure. Poor indoor air quality and Sick Building Syndrome are closely linked to the way we design, assess and deliver buildings, the health of occupants, the demands for energy and the provision of environmentally sustainable buildings. The inquiry, therefore, neatly meshed the Committee's infrastructure focus with its environmental focus.

The Committee learnt that poor indoor air quality and associated health problems like Sick Building Syndrome are costing hundreds of millions, if not billions, of dollars per year in lost productivity. Indeed one estimate, based on US studies, suggested that indoor air pollution could be costing the nation $12 billion annually.

To these costs need to be added the hidden health costs borne by workers and society through sickness and ill health. Some research indicates that between 40 and 60 per cent of office environments are affected by Sick Building Syndrome. In the United States health problems associated with poor internal air quality are regarded as one of the top five key environmental health risks.

In addition to these health and productivity concerns, current building design and operation is consuming large chunks of energy in order to support this artificial environment. There are then significant operating costs associated with poorly designed buildings.

The Committee was advised at public hearings that this inquiry is indeed timely. The Committee is certainly of the view that it is time to deal with the problem and it is important to do so before legal action from those affected by SBS forces governments to act.

Unfortunately, the factors which affect indoor air quality are the responsibility of a range of public sector agencies. So, from the Government's perspective, it is essential that the issue be given a focus and the Committee has recommended that the Government establish a working group with representatives from the relevant agencies to tackle the issue. This is its most important recommendation.

The Government, with its stock of low rise buildings, can provide the lead and the example in this area but the nature of the problem will require a concerted effort by a range of interested parties across all jurisdictions. There are implications for private sector buildings in this.

Indoor air quality should be given a specific focus in the Codes and Standards which set the framework for buildings in Australia, particularly the Building Code of Australia.

Wherever possible the totally artificial boundary between the indoor and the outdoor needs to be relaxed. This is the job of ecologically sustainable design which has to be more rigorously pursued. New building design has to integrate the need for technological solutions with benefits of our relatively benign climate, with its good sunlight and fresh air. The Committee was pleased to learn that these approaches have been developed and implemented by the Departments of Education and Training and Public Works and Services in New South Wales schools.

These innovative approaches will be encouraged through comprehensive life-cycle assessment in design. This could mean more up-front investment but will result in considerable savings over the life of the building. Expenditure on occupants is 92 per cent of outlays over the life of a building so investment that reduces those costs (reducing ill-health and increasing productivity) will be readily paid back.

Heating ventilation and air conditioning (HVAC) systems are one of the critical factors in the indoor air quality equation. Design needs to move away from an automatic recourse to full-scale mechanical ventilation systems. HVAC systems need to be designed to specific, high standards and maintained at those standards through compliance monitoring.

It is essential that buildings be constructed and fitted out with materials which do not pollute the indoor environment.

Existing buildings need to be better managed. For example, HVAC maintenance should ensure the elimination of microbiological contaminants, new fit-outs should not conflict with the design principles of the building and innovative solutions which allow prospective tenants to compare the quality of the indoor air in buildings should be developed.

Government procurement policies can be utilised to drive some of these changes.

The other vital component in addressing these problems is education for all those involved in the building industry as well as the general public.

The Committee is not suggesting a return to primitive, unpleasant buildings. Rather it is an arguing for a more balanced approach which combines the best of modern technological solutions with the lessons learnt from long experience and common sense. This should result in better health and a greater sense of well-being both at work and home, in improved productivity and in reduced demands on energy.

I would like to thank both my colleagues on the Committee and the staff for their hard work in completing this inquiry and I look forward to the Government's response to the Committee's recommendations.

Diane Beamer MP
Chairman

EXECUTIVE SUMMARY

In recent years governments have taken direct and decisive action on improving the quality of the ambient air, the Government's 1998 *Action for Transport* being one example.

In today's modern industrial society, however, people spend anywhere from 70 to 90 per cent of their time indoors. So the quality of that indoor air is an issue worthy of consideration.

Indoor air quality is defined as the nature of the air that affects the health and well-being of the building's occupants. Factors which impact upon the quality of the indoor air are the external air; the building materials and the heating, ventilation and air conditioning (HVAC) systems (through air temperature, humidity and ventilation rates); and the interior of the building (layout, furnishings, fittings and equipment).

Current indications are that poor indoor air quality has adverse implications for health. The consequence of this is a reduction in the quality of life for occupants, loss of productivity for employers and the potential for costly legal action against those with legal responsibilities for these indoor environments.

A number of health problems are associated with indoor air pollution, including Building Related Illness (BRI), Multiple Chemical Sensitivity (MCS) and Sick Building Syndrome (SBS)

Sick Building Syndrome is a condition which affects a significant number of building occupants but which abates when the occupants leave the building. The symptoms occur in a higher proportion of the building occupants than in the community generally. SBS is not confined to office buildings.

The symptoms include:

- Sensory irritation to eyes, nose and throat manifesting as pain, a feeling of dryness, smarting, stinging irritation, hoarseness or voice problems
- Neurotoxic or general health problems such as headache, sluggishness and mental fatigue, reduced memory, reduced capacity to concentrate, dizziness, intoxication, nausea and vomiting, and tiredness.
- Skin irritation, including pain, reddening, smarting, or itching sensations or dry skin.
- Non-specific hypersensitivity reactions, including running nose or eyes, asthma-like symptoms among non-asthmatics, or sounds from the respiratory system
- Upper respiratory/mucus membrane symptoms.
- Odour and taste sensations such as changed sensitivity of olfactory and gustatory senses or unpleasant olfactory or gustatory perceptions.

While there is no unanimity on the precise causes of SBS, there is enough agreement in the available material to satisfy the Committee that the causes of SBS are multifactoral. It is essentially a 20th century condition closely related to the way buildings are designed, constructed, fitted out and operated. In general terms causes are:

- Poor building design, particularly the complete isolation of occupants from the outside environment and the recourse to artificial lighting and "air"

- Indoor air pollutants (chemical, biological and physical from building and fitout materials and HVAC systems)
- Poor design and operation of Heating, Ventilation and Air Conditioning Systems
- Psychosocial factors such as management attitudes in the workplace, stress and interpersonal relationships.

Various estimates exist as to the costs and extent of SBS. The World Health Organisation estimated that as many as 30 per cent of new and refurbished buildings are subject to complaints about internal air. Other research suggest that SBS occurs in 40 – 60 per cent of office environments.

The hidden health costs of SBS on this scale must be significant.

Research in the US indicates that productivity losses due to poor indoor air quality could be between 0.3 per cent and 2 per cent of gross domestic product. This would translate to an annual cost of between $1.7 billion and $11 billion per year in Australia. Other estimates are more modest but still substantial, being in the range of $100 million to $125 million.

A number of legal cases, both here in Australia and overseas, have dealt with indoor air quality and SBS problems. The potential cost of adverse legal decisions, or out of court settlements, could well become the driver for change in this area unless other action is taken.

The Committee is convinced that poor indoor air quality and associated Sick Building Syndrome are impacting on the health and productivity of building occupants. This impact has significant cost and health ramifications. It is a matter on which action needs to be taken.

Unlike the outside air, there is no single public sector agency responsible for indoor air quality. It is the view of the Committee that this is one reason why little attention and few resources have been given to the matter. IAQ is a complex issue and it can only be addressed across a number of portfolios and across a number of jurisdictions. As a first step, the Committee recommends that an Inter-Agency Standing Committee (IASC) be established to commence action on indoor air quality in NSW. Treasury should provide some initial seed funding. However, the Committee has identified agencies for the Standing Committee with a direct core role in IAQ issues and is of the view that after initial set up the activities should be funded from each agency's budget. The IASC is to be responsible for implementing this report's recommendations. (See Recommendation One)

There are no standards or codes which deal specifically with SBS. There are, however, a number which deal with aspects of indoor air quality, mostly relating to HVAC systems. What is in existence is a multitude of documents with varying degrees of standing which are confusing and are not comprehensive. The Committee has made a number of recommendations in this area. (See Recommendations 3,7,8)

In addition to the recommendations outlined above, the Committee identified a number of strategies to improve IAQ and reduce SBS. Some address specific SBS causal factors (to the extent that they are identifiable) while the others seek to generally ensure good quality indoor air. The strategies fall into three categories:

1. New buildings
2. Managing existing buildings
3. Education

1. New Buildings

Design (See Recommendations 4, 5, 6, 9)
Any policy should seek to prevent problems rather than cure them. It is important then to design new buildings to prevent the SBS problems occurring. This is the most effective strategy for control.

Design based on sustainable design principles would reduce or remove many of the factors which adversely affect air quality. This in turn would significantly reduce energy use and associated costs. It is essential that genuine life-cycle costing form part of the design analysis.

The automatic recourse to technological solutions needs to be questioned and consideration given to alternative solutions as part of the design process.

The Department of Public Works and Services in conjunction with the Department of Education and Training has been developing this approach in schools for many years. There is, as a result, a pool of knowledge and expertise already in that department.

The DPWS is the Government procurement expert and the development of implementation of the strategies recommended by the Committee will require action through government procurement of both capital works and goods and services.

HVAC Systems (See Recommendations 10, 11, 12, 13, 14)
These systems play a vital role in the operation of the indoor environment and have the potential to adversely affect it. This is of particular importance as it is generally regarded that SBS is worse in mechanically ventilated buildings. There are options to full mechanical ventilation, such as natural and hybrid ventilation systems. These latter systems are well suited to the climate of NSW and much of the public sector building stock, which is not usually high rise in nature. Ways to provide individual control to workspaces should also be sought.

If mechanical systems are used they need to be carefully designed with IAQ issues in mind. There are a number of factors which need to be considered in this regard. These are identified in the report and include the zoning, ducted vacuum cleaning, overnight flushing etc.

Limiting Material Pollutants(See Recommendations 15, 16, 17, 18)
The modern, technological dimension to SBS is no more evident than with regard to contemporary materials used today. Many of these are proving harmful to our health by giving of chemical pollutants. A reduction, or preferably, the removal of them from buildings will greatly improve the indoor air quality. Fit outs need to be designed with this in mind. Information on materials needs to be made available to decision makers.

Commissioning (See Recommendations 19, 20)
The quality of the indoor air can be adversely affected simply because new buildings are not properly set up prior to occupation. Complex HVAC systems need to be properly calibrated and adjusted. The effects of high levels of outgassing which occur when materials are new can be substantially ameliorated if buildings are allowed to cure before being occupied.

2. Management of Existing Buildings (See Recommendations 21, 22, 23, 24, 25)
It is important to address air quality in existing buildings because the significant costs and health concerns identified relate to the current stock of buildings.

A range of problems in existing buildings, need to be addressed, including:

- poor internal layout,
- poorly maintained and operating HVAC systems,
- indoor pollutant levels,
- inappropriate cleaning methods and materials, and
- occupiers' activities.

All these concerns need to be addressed.

Of particular concern is the proper maintenance and cleaning of HVAC systems.

There is currently no regulatory regime to ensure that HVAC systems are regularly checked to ensure they are operating at design specifications, unlike the system in New Zealand. Nor does there appear to be any incentive for building owners and managers to see that this occurs.

Furthermore, and perhaps even more importantly, microbiological growth on air conditioning systems (fins, coils etc) are now considered to contribute toxins into the air which in turn affects immune systems of occupants, as do unclean filters which encourage fungal growth. The good news is that recent developments to deal with both these problems have considerable pay-off in energy savings, thus providing an incentive for this vital work to be carried out. Latest techniques to maintain and treat HVAC systems need to be investigated.

4. Education (See Recommendation 26)

Education is an invaluable tool for improving indoor air quality, particularly in residences. The Committee has identified a number of education initiatives to tackle the problem. These are:

- Green Offices initiative
- Information booklet for the public
- Resource information for architects, designers, owners, managers and maintenance staff, for example, DPWS could disseminate examples of leading environmental design for schools and other buildings for the benefit of the design and building industry. This could be done in collaboration with Royal Australian Institute of Architects

RECOMMENDATIONS

Coordinated Approach

1. THAT the Government establish an Inter-Agency Standing Committee (IASC) to provide a strategic approach to indoor air quality issues, including Sick Building Syndrome, in New South Wales. The Standing Committee should:

- include (but not be restricted to) the following agencies: Government Asset Management Committee (Premiers Department) EPA, DPWS, Dept of Health, WorkCover and SEDA;
- be responsible for implementing the recommendations of this report (including raising the issues at appropriate national forums); and
- Initially be funded with a seed grant from Treasury. It should then operate on agency budgets as these agencies have been identified because the issue forms part of the core business of each agency.

Research

2. THAT the IASC:

    1. Identify sources of funding for a research project to precisely identify the extent of SBS in the public sector in New South Wales. The findings would be used to refine strategies identified in the recommendations below.

    2. Consider ways to access all relevant data compiled in NSW on IAQ/SBS issues

Reducing SBS in New Buildings

Design

3. THAT the Building Code of Australia include specific measures to ensure IAQ which promotes occupant well-being

4. THAT Government agencies utilise the expertise of environmental architects and designers in the design phase of buildings in order to minimise possible IAQ problems by looking at the full range of design options.

5. THAT as part of the implementation of ESD principles the Government establish a review committee to vet proposals for significant capital works projects with respect to design elements to ensure high quality IAQ

6. THAT the optimisation of IAQ be part of the tendering process for relevant capital works projects as part of the implementation of ESD and life-cycle costing principles. New buildings should have clearer documentation and guidelines relating to SBS prevention.

7. THAT an SBS best practice guide for designers be produced

8. THAT SBS specific practice codes be developed for building construction.

9. THAT the IASC consider ways to implement the DPWS/ Education and Training model of ESD more broadly across the public sector.

HVAC systems

10. THAT new buildings be designed to:

    - Minimise heating and cooling demands of ventilation
    - Minimise the introduction of polluted ventilation air
    - Minimise energy demands of supplying and removing air

11. THAT the use of new HVAC technologies, such as hybrid air conditioning, 100% fresh air systems and high quality air filters be considered on a case by case basis as part of the design of new buildings or as part of major renovations.

12. THAT the design of HVAC systems should, where feasible, provide occupants with individual control over their workspaces.

13. THAT, where possible HVAC systems should be designed with the final use and layout of the building in mind. Where this is not possible, building internal layouts should not conflict with existing HVAC systems.

14. THAT AS 1668.2 include provisions to specifically improve IAQ, particularly SBS.

Limiting Material Sources of Indoor Air Pollutants

15. THAT the interim national IAQ goals recommended by National Health and Medical Research Council be adopted.

16. THAT a database (along the lines developed in Europe) or best practice guide be established containing information on low emission building products, finishes and furnishings for use by architects, designers, developers and clients

17. THAT the Government implement a program to phase out the use of products, finishes and furnishings which contain toxic chemicals such as volatile organic compounds. For example, strategies to encourage the use of low emission products, such as preferential treatment as part of tenders and contracts and inclusion in industry codes and standards, could be developed.

18. THAT the sale of high emission appliances (photocopiers/ printers etc) be discouraged or phased out. Fuel burning appliances should be flued to the outside.

Commissioning

19. THAT new buildings be “cured” before occupation by being “flushed out” (extended period of ventilation).

20. THAT, where HVAC systems are installed, careful and correct commissioning of the system be carried out to ensure the system performs to the design.

Management of Existing Buildings

21. THAT a "compliance schedule" for mechanical ventilation and air-conditioning systems be included in the Building Code of Australia to ensure the systems are fit for health. (Such an approach was included in the New Zealand 1992 Building Regulations)

22. THAT the HVAC systems in buildings be monitored on an annual basis to ensure compliance with the "compliance schedule" recommended above.

23. THAT HVAC "compliance" requirements include techniques which ensure the control of microbiological material (such as slime) and fungi in the HVAC systems.

24. THAT the development of a graded building rating system (similar to the energy system on appliances) be investigated which would enable potential tenants and users to compare buildings.

25. THAT quantified conditions relating to air quality and thermal comfort be negotiated and documented in the contract as part of lease negotiations.

26. THAT cleaning protocols or standards need to be reviewed or established to guarantee that cleaning is carried out for the purpose of protecting health (and not just for appearance). For example, the process must ensure the proper cleaning of carpets to remove dust mites and must avoid the use of hazardous cleaning agents. Realistic timeframes for cleaning contractors to properly clean buildings need to be ensured.

27. THAT codes or guidelines be developed to encourage office fitouts to use non polluting materials and not to impact upon the operation of HVAC systems.

Education

28. THAT education programs on SBS and IAQ be implemented to raise awareness across all sectors of the community. Specific areas for action would be:
    - Green Offices initiative;
    - Information booklet for the public
    - Resource information for architects, designers, owners, managers and maintenance staff, for example:
        - DPWS to disseminate examples of leading environmental design for schools and other buildings for the benefit of the design and building industry. This could be done in collaboration with Royal Australian Institute of Architects

CHAPTER ONE

Background to the Inquiry

1.1 Public Works Committee

The Standing Committee on Public Works was originally established in New South Wales in 1887. Its operations were suspended in 1930.

It was re-established by Motion of the Legislative Assembly on 25 May 1995 with the following Terms of Reference:

That a Standing Committee on Public Works be appointed to inquire into and report from time to time, with the following terms of reference:

> *As an ongoing task the Committee is to examine and report on such existing and proposed capital works projects or matters relating to capital works projects in the public sector, including the environmental impact of such works, and whether alternative management practices offer lower incremental costs, as are referred to it by:*
>
> - *the Minister for Public Works and Services, or*
> - *any Minister or by resolution of the Legislative Assembly, or*
> - *by motion of the Committee.*

The Standing Committee on Public Works absorbed the functions of the Standing Committee on the Environmental Impact of Capital Works, established during the 50th Parliament.

The terms of reference were renewed on 3 June 1999.

The Committee comprises seven members of the Legislative Assembly:

- Ms Diane Beamer MP, Chairman
- Mr Matthew Brown MP, Vice Chairman
- Mr Paul Gibson MP
- Mr Kerry Hickey MP
- Mr Andrew Humpherson MP
- Mr Adrian Piccoli MP
- Mr Tony Windsor MP.

The Parliament's intended role for the Committee was detailed in a speech given to the Parliament by the Hon Paul Whelan, Minister for Police and Leader of the Government in the House, on 25 May 1995:

> The Committee may inquire into the capital works plans of State-owned corporations and joint ventures with the private sector. The Committee will seek to find savings in capital works programs whilst achieving a net reduction in environmental impacts by public sector developers. The Committee's work is expected to provide incentives to the

> public sector to produce more robust cost-benefit analyses within the government budgetary process and to give more emphasis to least-cost planning approaches. The Committee will be sufficiently resourced to enable it to conduct parallel inquiries into specific projects and capital works programs generally.... it will have sufficient resources to inquire into the capital works program of all government agencies whose capital works programs affect the coastal, environmental and transport sectors.

In the Fifty-First Parliament, the Committee examined health, education, Olympics, waterways and transport infrastructure as well as urban and environmental planning issues. It also investigated the development and approval processes for capital works procurement across the public sector.

In the current Parliament, the Committee has tabled six reports:

- *Report on Capital Works Procurement* (Report No.1, September 1999).[1]
- *Report on the National Conference of Parliamentary Public Works and Environment Committees 1999, Hobart, Tasmania*
- *Infrastructure Delivery and Maintenance, Volume One – Office Accommodation Management*
- *Report on National Conference of Parliamentary Public Works and Environment Committees, 2000, Darwin, Northern Territory*
- *Follow Inquiry into Lake Illawarra Authority Report and School Facilities Report*
- *Infrastructure Delivery and Maintenance, Volume Two – Analysis of Plant and Equipment Management*

Currently, the Committee is conducting the following inquiries:

- *Infrastructure Delivery and Maintenance, Volume Three – Building Maintenance*
- *Government Energy Targets*.

1.2 Terms of Reference

In September 1999, the Committee resolved to adopt the following terms of reference for the inquiry:

The Committee to inquire into Sick Building Syndrome with specific reference to:

- The symptoms, causes, costs and frequency of Sick Building Syndrome
- The cost of rehabilitating sick buildings and/or providing alternative accommodation
- Design factors and building assessment and management strategies which will minimise exposure to Sick Building Syndrome in the future, including accommodation acquisition procedures (leasing arrangements), monitoring buildings and design of new buildings.

[1] This Report represents Volume II of a joint inquiry in the Fifty-First Parliament with the NSW Public Bodies Review Committee into the Provision of Goods and Services and the Delivery of Capital Works in the NSW Public Sector. The draft Report was carried over to the Fifty-Second Parliament by a motion of the Legislative Assembly of 29 June 1999, which referred all documents and proceedings of Committees of the Fifty-First Parliament to current Committees.

1.3 Methodology

The Committee carried out its inquiry as follows:

- advertised the inquiry
- received submissions
- carried out its own research
- held public hearings
- held meetings and discussions
- prepared its report based on all the information gathered

1.4 Report Structure

The report is divided into three sections, as follows:

Chapter Two provides background to Sick Building Syndrome by looking at the more general notion of indoor air quality (IAQ). It describes the major factors influencing IAQ and outlines the implications of poor indoor air quality, particularly the costs through poor health and lost productivity

Chapter Three looks at Sick Building Syndrome - a health problem associated with poor indoor air quality - its definition, symptoms, causes and costs, both social and financial. The chapter then looks at the regulatory framework for SBS.

Chapter Four sets out the Committee's recommendations to address both poor indoor air quality and sick building syndrome.

CHAPTER TWO

Indoor Air Quality

2.1 Indoor Air Quality

The notion of an indoor environment probably had its origins in the United States when a Dr Willis Carrier attempted to increase comfort by separating occupants from the (outside) summer heat. In so doing he prevented the balancing of the indoor and outdoor environments, thus "creating a distinction between the indoor and the outdoor air quality. Indoor air quality (IAQ), and associated malaises are then modern, twentieth century phenomena."[2]

Today, in Australia, it has been estimated that the majority of people spend as much as 70 to 90 per cent of their time in an indoor environment. Indeed, "the most susceptible segments of the population: the very young, old and sick spend close to 100% of their time indoors".[3]

As Australia moves more and more towards a service-based economy and society, it is likely that an increasing number of people will spend more time indoors. Indeed our whole lifestyle these days seems to be enclosed by built environments including, homes, offices, transportation systems, shopping and entertainment centres, educational and health facilities and sport and leisure centres.[4]

While considerable attention has been given to the impacts of outdoor (ambient) air on our health, as attested by the Government's *Action for Air* strategy, relatively little concerted attention has been given to the effect on the community of such long exposure to any indoor air pollution.

In fact, "indoor air pollution in built environments would be one of the least realised and appreciated environmental risks to public health in Australia".[5] "US regulatory authorities cite IAQ as one of the top five key environmental health risks or our time".[6]

Yet it is widely accepted that indoor air is generally of a poorer quality than ambient air.[7] There is, therefore, considerable potential for the health of the community to be adversely affected in the indoor environment.

According to a recent federal government report, Indoor Air Quality is now a significant issue requiring "comprehensive strategies".[8] The report concluded that:

> *.... there is[in Australia] no cohesive and well-articulated policy framework under which resources for investigation and mitigation [of IAQ] can be marshalled.*
>
> *This is in striking contrast to the United States, where, for example, the US Congress passed the Radon Gas and Indoor Air Quality Act (1986), which provided a direct Congressional mandate for a national indoor air research program. The Act directs the USEPA to research, coordinate and disseminate information to the public about IAQ....*

[2] Building Science Forum of Australia, NSW Division, Seminar Papers, *A Canary in the Office* 26 February 1997, p27
[3] Department of Health and Aged Care, Environmental Health Section, *Indoor Air Quality A Report on Health Implications and Management Options*, June 2000, p132
[4] Sharah K, Strategic *Approach to the Control of Indoor Air Pollution and Other Health Issues in the Built Environment* AIRAH Journal, v53 no3, 1999, pp30-35
[5] ibid
[6] Material supplied by Airway International. For more information see Appendix G.
[7] Department of Health and Aged Care, op cit. p20.
[8] Ibid, p172.

> *There is an urgent need to …. establish a mechanism to assess the issue and advise policy makers to assist in prioritising policy.*

The Committee aims in this report to address some of these indoor air quality concerns, particularly with reference to Sick Building Syndrome.

2.2 Factors influencing IAQ

Many factors can influence the indoor environment, including heating, lighting, ventilation, occupant space configuration and the type of activity carried out in the building.[9] Not all these factors necessarily influence IAQ.

The definition of indoor air quality (IAQ) used by Environment Australia in the *State of the Environment Report* (Technical Paper series 1997) is "the totality of attributes of indoor air that affect a person's health and well-being".[10]

While IAQ is a contemporary issue, the result of how we relate to our modern, artificial environment, it has become a particular issue in the last 25 years.

> *"Indoor air pollution has been a subject of increasing concern since the energy crisis in the late '70s when oil prices dramatically increased. The potential for poor indoor air quality problems to develop are partly due to attempts to reduce energy costs by reducing the amount of intake of fresh air to air conditioning systems and efforts to make buildings as air tight as possible to avoid loss of treated air from buildings. Added to this is the change of materials to fit out buildings, wider use of wall to wall carpeting and soft screens for noise abatement and other materials of synthetic origin which result in the emissions of a variety of chemical compounds into the indoor environment".*[11]

In other words, "efforts to reduce energy consumption and isolate the indoor from the outdoor environment often result in additional deterioration of indoor air quality".[12]

The quality of the indoor air is affected by three aspects of the built environment. These are:

- The external environment (which enters the building)
- The building itself (including design, structural materials and HVAC systems)
- The building interior (activities of occupants, layout, furnishings, fittings and equipment)

Problems with the indoor air quality then stem from the environment in which the buildings are situated, the way they are built and fitted out and the way they are operated.

Indoor air should satisfy thermal and respiratory requirements, prevent unhealthy accumulation of pollutants and allow for a sense of well-being.

[9] Building Science Forum of Australia, NSW Division, op. cit. p3.
[10] Weslowski, J. (1987). An Overview of the Indoor Air Quality Problem: The California Approach. Clean Air 21, 134-142.
[11] Building Science Forum of Australia, NSW Division, op. cit. p1
[12] Department of Health and Aged Care, op cit. p132.

Among all the factors which influence indoor air quality, three are critical:

- Indoor air pollutants
- Heating, ventilation and air conditioning systems
- Building design.

It should be noted that these factors are not distinct but overlap and interact with each other. And, while these are certainly not the only influences, they are the major ones. Accordingly, the committee discusses them in detail below.

2.2.1 Indoor Air Pollutants

Pollutants are substances which contribute to the reduction of human comfort or health.

Indoor air pollutants can originate from within a building or can be drawn from the outdoors through ventilation systems. It is likely that the concentration levels and number of pollutants is "much higher indoors than outdoors due to the presence of indoor specific sources".[13]

There are three main pollutant sources:

i) Chemical pollutants

These include volatile organic compounds (VOCs), particularly formaldehyde, pesticides, cigarette smoke, heavy metals and combustion products such as carbon monoxide and nitrogen dioxide. Chemical pollutant levels indoors can vary at different times of the day or night and even within different parts of the building.

There are literally thousands of organic compounds released into the atmosphere at room temperature. Over 5,000 have been identified in indoor air. VOCs originate from building materials, furnishings and equipment such as adhesives, carpets, manufactured wood products and cleaning products. VOCs have low boiling points and therefore readily become gases in indoor air. Other materials act as chemical sinks that absorb the chemicals and re-release them over an extended period. Since emissions are at their highest when these materials and furnishings are new, newly constructed and refurbished buildings represent the greatest potential hazard to health in terms of IAQ levels. Emissions tend to dissipate over time.

Formaldehyde

Formaldehyde is the most commonly identified VOC in indoor environments. It is a major component of indoor air pollution owing to its extensive use in the manufacture of a large range of domestic products and construction materials commonly found in offices, homes, schools and public buildings. It is used in the manufacture of a range of composite boards such as particle board, chipboard and plywood which are used extensively in buildings and furniture. It is also present in carpets, floor linings, insulation foam, furniture foam, glues, permanent press fabric, fireproof and shrinkproof materials and paper products.

Other significant sources of formaldehyde include unflued combustion heaters and tobacco smoke. These products outgas formaldehyde into the air, often at levels that cannot be detected by human senses. The amount of formaldehyde outgassed increases with increased temperature and/or humidity.

[13] ibid

While formaldehyde emissions generally decrease over time, in some cases significant outgassing can still occur for a number of years.

ii) Biological pollutants
These include bacteria and viruses; moulds, mildews and yeasts; dust mite allergen, pollens, and fungi. It has been estimated that in the US up to 20 million people suffer allergic reactions to moulds, mildews and yeasts.

Biological contaminants can pollute the indoor environment in a number of ways, such as "when living, dead, or debris from dead organisms are distributed by ventilation systems; when the contaminant is physically disturbed; when a solid component of the organism dissolves in water and then aerosolized; and when noxious gases from contaminants are released into the indoor environment."[14]

Bacteria can and do have effects on humans. One class of bacteria, called endotoxins, form part of bacterial biofilm, commonly called 'slime', which invades wet surfaces. This biofilm continuously becomes fragile and sloughs off. Endotoxins affect respiratory function, even at low concentrations and can cause inflammatory effects.[15]

iii) Physical pollutants
These include radiation from radon and electromagnetic fields, dust and respirable particulate matter such as fibres.

An extensive list of the sources of indoor air pollutants, and their effects, is included at Appendix A.

Many of these pollutants are always present and it is important to consider is the concentrations at which they occur relative to the levels at which they harm human health. However, in circumstances where indoor pollutants are found at levels below those known to cause harmful effects, they may combine with other pollutants, climatic factors, individual susceptibilities and psychological factors to create the non-specific symptoms associated with Sick Building Syndrome.

The Australian National Health and Medical Research Council considered the issue of indoor pollutants as early as 1989. It argued that, assuming the same levels of exposure, the "adverse effects of air pollutants would be the same indoors as for outdoors". Accordingly, it recommended that "the ambient air quality goals should also apply to the indoor environment". Research has since confirmed that "in many cases the quality of indoor air closely mirrors ambient pollution levels (ie where there is an absence of indoor pollutant sources). The NHMRC has since then established air quality goals for VOCs and Radon for the indoor environment.[16]

2.2.2 Heating, Ventilation and Air Conditioning (HVAC) Systems

HVAC systems control many aspects of the indoor air environment. They are the 'lungs' of the building. They supply, filter and distribute outside air, regulate the climate in the building, and supposedly dilute and remove polluted indoor air.

Since "poor design and inadequate maintenance of air conditioning systems contribute greatly to poor air quality,"[17] their design operation and maintenance are critical to IAQ.[18]

[14] Dombrowsky Y and Hill J, Health Complaints in Air Conditioned Buildings – Based on an Analysis of Existing Scientific Data about Sick Building Syndrome, AIRAH International Conference, 1998
[15] ibid
[16] Department of Health and Aged Care, op cit. p161.
[17] Building Science Forum of Australia, NSW Division, op. cit. p63.

Air conditioners in Australia work on the principle of recirculating internal air and introducing small amounts of outside air. This inadequate ventilation or air circulation can allow a build up of air pollutants. The low amounts of introduced outside air are mainly aimed at reducing energy costs because outside air requires more energy to bring it to the desired temperature. This points to a potential conflict, in conventional air conditioning, between better indoor air quality (increased amounts of outside air) and environmental sustainability (decreased amounts of outside air to reduce energy costs).

Air conditioning settings are usually based around an accepted 'human comfort zone'. This zone is defined as ranges of temperature and humidity in which it has been agreed that humans are comfortable. Currently these recommended levels are:

Temperature

Summer 22 - 25 deg. C
Winter 20 - 23 deg. C

Humidity 35 - 65%

Once inside the HVAC system, outside air is usually mixed with recirculating building air and is heated or cooled to predetermined levels. The mixture of this air at different temperatures creates moisture. This moisture can encourage of biological pollutants such as biofilm. These pollutants are then transported through the air ducts into occupied areas, where the contaminants come in contact with building occupants.

The "microbiological contamination of air handling equipment such as chillers, condensation trays and also of the furnishings including carpers due to water contact" has resulted in the "development of allergies to moulds and fungi by immune system sensitisation". This has result in considerable costs through worker illness.[19]

Another source of pollutants is HVAC air intakes which can be affected by dirt, standing water, and bird roosting.

As well as the problems identified above, HVAC systems may prove inadequate for a building's proposed use, structure or layout. Three common problems may follow:

- Fresh air intake quantities may prove inadequate, even at full capacity, resulting in insufficient volumes of fresh air.
- Air may be poorly distributed, both within rooms and between zones, due to badly located and designed ducts and diffusers. Air may be 'short circuited' by incorrectly located grills. These problems result in inadequate and uneven circulation to all occupants, creating stuffiness or draughts. Poor circulation can also be caused or exacerbated by poor office practices, such as blocking grills with boxes and other office paraphernalia, or failing to make use of available ventilation such as louvres and openable windows.
- Limited physical access to the ventilation system — a not uncommon occurrence — can make cleaning and maintenance difficult.

[18] Immig J, Rish S, Brown S, Indoor Air Quality Guidelines for Sydney Olympic Facilities, CSIRO BCE Technical Report TR 97/3, December 1997, p12
[19] Building Science Forum of Australia, NSW Division, op. cit. p5.

According to some, HVAC systems have unnecessarily created the physical and psychological separation of indoor and outdoor. The process is self-fulfilling. The existence of air conditioning "creates certain parameters of comfort which only it can deliver. Affluent cultures have become air conditioning dependent".[20]

2.2.3 Design

Design is another factor which is critical to indoor air quality. The design determines the shape, size, location and orientation of the building. It also determines whether natural or mechanical ventilation in utilised and the construction materials used.

Interior design is just as vital from an indoor air quality perspective. This stage specifies the materials, furnishings and finishes (the source of so many pollutants) and the final layout of the internal spaces.

Indeed the needs of employees and customers in the office environment, as reflected in the internal layouts, are generally ignored. They are "nearly always an afterthought", if they are considered at all.[21]

Some of the problem areas identified for IAQ, such as pollutant sources, mechanical ventilation and psychological responses are the product of the marriage of modern technology and the design of buildings.

Some argue that indoor air and outdoor air have been separated by design; and it is now time to reconnect them by design.[22]

Given the importance of design in this matter, the Committee took evidence from two highly qualified and regarded architects, Lindsay and Kerry Clare.

In his evidence to the Committee, Mr Clare pointed out how technologies, such as air conditioning and artificial lighting, have allowed building designers and developers to change the design of buildings, particularly office blocks:

> **Mr Clare:** If you look at buildings a century ago when technologies were quite different, buildings had to address those issues. If you went down Macquarie Street or any city where you looked at a building which looked like a grand fat building, as I call them, they were actually thin buildings because they always had courtyards taken through so the occupants had natural light and ventilation. With the advent of technological advances in this century I think people have become lazy. The cheapest way to design a building or make a building is to actually make a fat building with the smallest amount of light. In fact, the cheapest one is a cube with no windows. You could technically have a light switch and an air conditioning unit plugged in and you could say it would be habitable. Not much different to this room perhaps[23]. I think that is being lazy. If you look at a place like the east coast of Australia, say between Sydney and southern Queensland, it is blessed with a good microclimate where the conditions are quite pleasant for the majority of the year.[24]

[20] Ibid p17.
[21] Ibid p23
[22] ibid p17
[23] The witness was referring to Room 814/815 in the New South Wales Parliament House
[24] Transcripts of Evidence p36

The Clares argued that building designers have become locked in to technology. The mere existence of modern technology such as electric lighting and mechanical air conditioning units makes them almost mandatory, particularly in office blocks, without reference to other options which might exist for specific situations and which could improve the quality of the indoor environment.

They highlighted these points with a case study.

Sydney Cove Passenger Terminal
The NSW Government Architect was commissioned by the Sydney Ports Corporation to design a substantial upgrade to the Sydney Cover Passenger Terminal. Part of this upgrade included the use of the Customs Hall as a function space. As design directors for the Government Architect, the Clares considered that this waterfront space would benefit from an improved natural ventilation system based on passive principles rather than simply 'adding' an air conditioning system.

The existing ventilation system to the hall was not working largely because the high level ventilation was fixed in a shut position. As the majority of waterfront functions would quite naturally use the space with doors open to the balcony overlooking the harbour and the Opera House, the Clares felt that full air conditioning would be inefficient. They sought an opinion from an environmental design expert on whether an upgraded passive ventilation system would work during functions. That opinion was favourable.

Despite the design directors' recommendation to the agency and its project managers, a mechanical air conditioning system is to be installed. Yet the consultant mechanical engineer has advised the Clares that the air conditioning will not work well with the balcony doors open, nor will it cope with extremes of heat.

2.3 Impacts of poor indoor air quality

There are a number of implications and costs associated with poor IAQ. The resulting unsatisfactory indoor environment can mean:

- increased risk of unacceptable public health
- less satisfied occupants
- reduced productivity
- increased running and maintenance costs
- reduced life of building components
- possible litigation[25]

The Committee looks at a number of these factors in more detail below.

2.3.1 Health problems

As pointed out above, a large section of the Australian population spends a significant amount of time indoors. If the quality of indoor air is unacceptable, then major health problems are a likely consequence.

The adverse effects, in the form of illness and complaints, of inadequate indoor air quality on the health and well being of occupants is now being recognised.

[25] Sharah K op cit

The Department of Health and Aged Care report, published last year, stated that "the authors of this review are of the opinion that there is a demonstrable link between poor indoor air quality and negative health responses."[26]

The National Environmental Health Strategy, released in 1999, pointed out that:

> *The quality of air in our homes, schools, recreation buildings, restaurants, public buildings, residential institutions and inside cars and offices is of significant concern. Pollutants can reach far greater concentrations indoors than they can outside.*[27]

Specifically, health complaints related to the indoor environment range from "issues of thermal comfort (draught, temperature and humidity) through to health outcomes such as nausea, headache, dry skin, flu-like symptoms and asthma". This can result in reduced productivity, both in the workplace and home. The response to poor indoor air manifests itself at one end of the spectrum as a "low level allergic response or a non-specific feeling of being 'unwell'" through to "absenteeism, a major allergic response or longer-term illness".[28]

Assessment of building-related illnesses in Australia is limited and is restricted to studies of office environments, hence there is a focus on productivity. The relevant studies are summarised below:

- Williams (1992) investigated the ventilation systems of 228 suburban low rise office buildings in Melbourne. Occupants of 62 per cent of those buildings experienced unacceptably stuffy, drowsy conditions. Eighty-two per cent of the buildings failed to meet current ventilation guidelines (largely due to changes in guidelines after the buildings were constructed).

- The Department of Health and Aged Care report, in discussing the work of Clemens-Croome and Bakke, noted that "a small percentage improvement in the health and productivity of 'workers' can have dramatic effects on company profitability."

- In an unpublished paper for the Community and Public Sector Union, McKenna reported that a multi-state survey of 511 Commonwealth Office workers in 1990 found that 91 per cent experienced discomfort or illness associated with poor ventilation or temperature control. Complaints included: too hot (72%), too stuffy (72%), drowsiness (48%), headaches (48%), and sore throat (55%).

- Dingle and Olden (1992) investigated a new, four-level office building in Perth where occupants complained of strong chemical odours and Sick Building Syndrome-like symptoms. They applied a self-response questionnaire to 44 occupants selected randomly from the building's 126 office workers. Symptoms and their incidences were: dry eyes (65%), tired and strained eyes (54%), reflection/glare (41%), fatigue (57%), sore throat (28%) and migraine (36%). Factors that were identified as possible contributors to these symptoms were window glare and high indoor temperatures.

- Kemp and Dingle (1994) described a range of SBS-like symptoms in 20-40 per cent of workers in a new, eight-level office building in Perth where occupants complained of strong chemical odours.

- Rabone et al. found no association between recent occupant mental distress (ie psychological causes) and work-related symptoms in 401 occupants of a 'sick' office building in Sydney.

[26] Department of Health and Aged Care, op cit. p11.
[27] National Environmental Health Strategy, 1999, p43.
[28] Department of Health and Aged Care, op cit. p160.

Instead, the symptoms were strongly associated with 'stuffiness' of the air — supporting a role of building factors rather than human factors in the cause of symptoms. *(State of the Environment Report)*.

- In one Australian study, microbiologist Dr McDougall took 200 airborne dust samples in office buildings and some manufacturing premises in the Northern Territory, Brisbane, Wollongong and widely in the CBD of Sydney between 1987-1989. The samples were analysed for bacteria and fungi associated with SBS and McDougal reported "wide ranging and in some cases horrifying results".[29]

The resulting problems are, however, not dramatically or immediately obvious, with the result that IAQ does not receive much attention.

Without a clearly defined cause and effect it was difficult to articulate "a public health message about something as nebulous as indoor air quality", which "rarely, if ever, gets 'star' billing".[30]

The Department of Health and Aged Care report observes that:

> *the effects of poor Indoor Air Quality are rarely dramatic. No 'smoking gun' here. Rather, the effects are decidedly covert, insidious and sometimes capricious. By example, a number of pollutants are known to exacerbate existing respiratory and pulmonary conditions, yet on death only the ailment itself is registered. Poor Indoor Air Quality doesn't figure in the cause of death statistics.*[31]

But the concerns are consistently expressed by experts.

The Department's report is blunt in its message, stating that, because the effect of poor indoor air quality can potentially touch the lives of nearly every Australian, it should be "a matter of nationwide importance".[32]

The National Environmental Health Strategy (which attempts a national approach to environmental health issues in Australia) "categorises indoor air quality as an issue of 'significant concern'".[33] It goes on to assert that "Australia needs comprehensive strategies which aim to reduce air pollution (ambient and indoor). These strategies need to take a holistic approach and cover all contributory areas." [34]

The Department of Health and Aged Care notes that "… it appears highly likely that a substantial, albeit as yet unquantified cost, is borne unnecessarily by the community" due to negative health responses to poor IAQ.[35] The report goes on to say:

> *…. A strong case can be made that poor health, induced by 'poor' air quality has a significant social cost. That cost, both financial and social, is currently borne out of sight – its impact simply hidden from traditional assessments or recording instruments. If at least some of this cost can be prevented, then society as a whole will benefit".*[36]

[29] Dr J McDougall, Submission to the Inquiry No 1.
[30] Department of Health and Aged Care, op cit. p11 and p15.
[31] Ibid p15.
[32] Ibid p11.
[33] Ibid p163.
[34] National Environmental Health Strategy, 1999, op cit. p43.
[35] Department of Health and Aged Care, op cit. p11.
[36] Ibid p13.

A significant potential social cost relates to children. The same report notes that "there appears to be strong evidence that the degree of exposure to some pollutants or allergens received in the first two years of an infant's life has a significant influence on that child's potential to develop physiological problems in later life"[37]. This is because children have higher respiratory and metabolic rates than adults, resulting in higher uptake of airborne pollutants without the resilience of adults. "This can result in an absorption rate of airborne chemicals, approximately 2-4 times greater than that of adults"[38]. This obviously has implications for institutions such as schools and child care centres as well as the home environment.

In its submission to the inquiry, the Total Environment Centre supported this view stating that children, particularly young children, are more vulnerable than adults to illness and that "there is a wide range of health and behavioural symptoms that may indicate a child is being affected by exposure to chemicals indoors."[39]

The submission cited a 1991 report which noted that "a number of diseases and behavioural problems in children, including asthma, chronic respiratory disease, multiple chemical sensitivity, chronic fatigue syndrome, suppressed immunity, irritability, decreased attention span, nervous system damage, impairment of fine motor skills and disrupted social and emotional development have been linked with chemical exposures."[40]

The matter was further emphasised at public hearings:

> **Ms IMMIG:** I would like to re-emphasise the importance of specific environments, particularly where children are present. So far sick building syndrome has focused very much on large office towers and that is very important but, as I mentioned, children are in a very high-risk category. They fall between the cracks in terms of a lot of occupational health and safety standards already which do not directly cover children's' working environments. I would very much like to see some priority emphasis placed on those environments so that we can look to ameliorating any problems that may exist there, and potentially through planning legislation—although there is a role for local governments obviously as well in terms of the location of schools and childcare centres away from outdoor sources of pollution which contribute in doors as well—to place a greater emphasis on priority areas of attention, including children.[41]

2.3.2 Costs of poor indoor air quality

Some attempts have been made to quantify the financial costs associated with poor IAQ. These have mainly focused on lost productivity and legal costs and to a lesser extent operating costs.

2.3.2.1 Lost Productivity

The research that is available, most of which is from overseas, suggests that the productivity losses are significant. They are summarised below:

- The United States Energy Management Institute suggests that the building environment can affect productivity by 1.5 to 5 per cent.
- The United States Environmental Protection Agency estimates annual economic loss due to poor IAQ at several tens of billions of dollars.

[37] Ibid p13.
[38] Ibid p165.
[39] Total Environment Centre et al, Submission to Inquiry, No 7
[40] ibid.
[41] Transcripts of Evidence, p16.

- The US Occupational Safety and Health Administration estimates that 30 per cent of commercial buildings in the US have IAQ problems, potentially affecting 21 million people. It says the economic impact of poor IAQ totals $8 billion per year in lost productivity and medical costs.[42].

- Hodgson (1989) maintains that the estimated cost of office workers in the USA losing an average of 6 minutes productive concentration per day has a national impact on productivity in the order of $10 billion a year.[43]

Other studies have looked beyond productivity:

- Woods postulates that, in the USA, medical care associated with major health-affecting cases of indoor air pollution exceed $1 billion annually, with estimated annual costs of medical visits in excess of $500 million.[44]

- A WHO report found that "as many as 30 per cent of new and remodelled buildings may generate excessive complaints related to indoor air quality. In a nationwide, random sampling of US office workers, 24 per cent perceived air quality problems in their work environments, and 20 per cent believed their work performance was hampered thereby."

- The WHO "has estimated the total cost (including absence from work, health care etc) of building related illness to be 0.5 – 1% of GDP".[45]

- David Rowe estimated in 1995 that the cost to Australia was in excess of $125 million per annum.[46]

2.3.2.2 Costs associated with legal action

The Committee looks in detail at the administrative and regulatory framework relating to Sick Building Syndrome in the following chapter.

However, legal actions and liabilities have potential cost implications for many involved, in one way or the other, with the built environment and indoor air quality. A number of cases both in Australia and overseas have been concluded with ramifications for IAQ and, therefore, potentially Sick Building Syndrome. These are summarised below.

United States

There have been cases in the US where plaintiffs have sued building owners and/or employers for health problems they have successfully argued were directly caused by the indoor environment in their workplaces. Two cases are:

Case One

In the US Environment Protection Agency outbreak in the United States it was reported that an award of nearly $1 million damages was made by a jury to five employees of the Agency. This was compensation for health impairment attributed to occupancy of its head office in Waterside Mall in the late 1980s when carpet replacement was undertaken while normal work in the building proceeded.

[42] Department of Public Works and Services, Submission to the Inquiry, No 11.

[43] Hodgson, M.J.1989. Clinical Diagnosis and Management of Building -related Illness and the Sick Building Syndrome." pp593-606. In J.E Cone and M.J. Hodgson (Eds.), Problem buildings: Building-Associated Illness and the Sick Building Syndrome. Occupational Medicine: State of the Art Reviews. Hanley and Belfus inc., Philadelphia.

[44] Woods, J.E. 1989. "Cost Avoidance and productivity in owning and Operating Buildings" pp753-770. In J.E. Cone and M.J. Hodgson (Eds.).op cit.

[45] Building Science Forum of Australia, NSW Division, op. cit. p28.

[46] ibid

It was reported that a further 14 cases were awaiting hearing. Compensation costs were additional to the cost of evacuating and relocating 8,000 employees in temporary accommodation and the remedial work in the building.[47]

Case Two

A large court house complex in Florida was evacuated and court activities were carried on in temporary premises for many months while extensive rebuilding was carried out to remedy defective workmanship that allowed entry of moisture and colonisation by moulds and fungi. It is understood that the cost was more than $US20 million [48]

The HAC report describes this case as the first Sick Building Syndrome case in the US. It provided the following details:

> *The plaintiff's case arose from alleged injuries suffered from contamination of the indoor air caused during tenant improvements to an office building. Seven building occupants claimed indoor air pollution resulted in personal injury including temporary and permanent health problems. The two companies for whom they worked claimed business losses as a result of exposure to the pollutants.*
>
> *The plaintiffs alleged:*
>
> - *VOCs entered and occupied spaces on the same floor from construction of ductwork containing solvents, and*
> - *Insufficient supply of outside air (not related to renovation work) had contributed to elevated VOC levels.*
>
> *The defendants included:*
>
> - *The insurance company (representing the developer and building owner)*
> - *The property management company*
> - *The construction manager*
> - *The architectural firm (designers of core and shell building)*
> - *The tenancy improvement contractor*
> - *The mechanical (air conditioning) contractor for the tenant improvements.*
>
> *It should be noted that additional defendants including the lease-building contractor, the tenant improvement space planning consultants and the indoor air quality consultants who investigated the original complaints settled with the plaintiff at an early stage of the proceedings. After testimony by only one third of the plaintiff's expert witnesses, the parties reached a monetary settlement believed to be seven figures.*
>
> *The case is important for several reasons:*
>
> - *It was the first IAQ case to reach trial stage – all other IAQ related lawsuits had been settled before the trial had begun;*
> - *The case involved a very common IAQ problem;*
> - *It resulted in a large settlement for the plaintiffs; and*
> - *Issues of both strict liability under statute and negligence were relevant.*[49]

[47] Vogt, C. (1994): "Waterside mall verdict sounds warning for building owners" in ed. Vogt, C., IAQ Update 7.2 Cutter Information Corp. Arlington MA.
[48] Mr David Rowe, Submission to the Inquiry, No 9.
[49] Department of Health and Aged Care, op cit. pp 168/9.

Australia

A number of cases which relate to illness from poor indoor air quality have been decided in Australia:

- Bishop v Commonwealth of Australia (1982). This "established that air quality within a building can be the subject of a compensation order and that the aggravation of a pre-existing allergy is not a bar to compensation".

- Glover v Australian Telecommunications Commission (1984). Compensation was not awarded. The case noted, however, "that a disease aggravated by conditioned air could be the subject of a compensation order, if sufficient evidence of the link between air quality and illness was presented."

- Carey v Australian Telecommunication (1985). A Commonwealth employee sought compensation before the Federal Administrative Appeals Tribunal under the Compensation (Commonwealth) Government Employees Act 1971 (C'lth). Here, a postal clerk with a history of asthmatic complaints complained that on moving to an air-conditioned building his condition noticeably deteriorated. The Tribunal found that the applicant had presented sufficient evidence. He demonstrated a genuine respiratory condition, and presented evidence that moulds and dust found in the building's air conditioning system aggravated his condition.

  Telecom presented evidence that the air conditioning system had been well maintained and clean. On this point the Tribunal said:

  > *Irrespective of the state of maintenance and cleanliness, the fact is that certain moulds, fungi and other substances are being circulated by the system and, for whatever reason, they have an adverse effect on the applicant ... If every component was cleaned daily, if every nut and bolt was tightened regularly, if the system was a paragon of punkahs, he would still be incapacitated.*

  In the Tribunal's view, liability under the Act was strict and, once the causal connection was made between the applicant's illness and the building's air conditioning system, liability accrued regardless of measures taken by the employer.

- In Accident Compensation Commission (Victoria College) v Bradley (Judge Bradley, Accident Compensation Tribunal of Victoria, 1989), a case very similar on its facts to Carey, the applicant was a TAFE librarian who claimed under the Accident Compensation Act 1984 (Vic).

  Evidence was presented to the effect that the applicant was highly sensitive to air contamination. The aggravation of her condition was due to recirculation through the building's air conditioning system of formaldehyde fumes from building materials in a new library building.

  The levels of formaldehyde were within acceptable standards but the judge was satisfied as to the causal connection between the applicant's injury and the building's air conditioning system, and, under the Act, liability was strict. Although Carey was not cited, the principles of that case were used.

  The case is notable in that Mrs Bradley cited sick building syndrome as one of her conditions in her statement claiming compensation. This is quite possibly the first claim of its kind in Australia.

- Favell Mort Limited v Murray (1975) touched on the subject of diseases contracted in buildings. An employee of the company had contracted mengo-encephalitis, possibly during a flight back to Australia, during the course of his employment. Barwick CJ made the following statement:

> *Had he been required by his employment to be at some particular place in a confined area, such as a building, and he was there attacked by a virus with the consequence experienced by him in this case, there would not seem to me to have been the same difficulty in accepting that he received the virus at the place where his employment required him to be and that, in consequence, that obligation of his employment contributed to his injury in the extended meaning of the word.*
>
> Again, this supports the view that diseases contracted in a building can be the subject of a worker's compensation claim. It was also the first High Court reference to a building-related illness.

- Western Suburbs Hospital v Currie (1987). The Court decided that the hospital owed a duty of care to patients and visitors.

The DHAC report notes that:

> *One interesting aspect that emerged from researching case histories is that there are no recent cases from which to draw further understanding of legal interpretation. It appears that cases are being settled out of court, which can provide a number of benefits for the defendant:*
>
> - *It may reduce costs;*
> - *It publicly is minimised; and*
> - *It removes the development of legal precedent.*[50]

2.3.2.3 Increased operating costs

The energy demands of poorly designed buildings, dependent wholly on mechanical ventilation and the inefficient operation of HVAC systems have significant cost implications.
For example, the build-up of biofilm on fins and coils systems in HVAC systems causes reduces heat transfer and significantly increases energy demands. The resulting energy costs to building owners can be significant. As well, the increased stress on HVAC systems can reduce the life of components thus further increasing operating costs.

Comment
Technology has provided societies with considerable benefits. In developed societies we have become much more dependent on creating artificial environments. This has been done for good reason, to improve our comfort in often difficult environments.

However, history has shown that technological developments can have impacts on human health.

Often the adverse impacts are not immediately obvious. Sometimes society has been slow to respond.

The dependence on totally artificial indoor environments which reduce the quality of the air we breathe is very likely to be causing health problems and reducing our productivity.

There is enough research and expert opinion to satisfy the Committee that the quality (or lack of quality) of indoor air in many buildings is affecting the health of building occupants. Studies consistently show significant numbers of building occupants (usually workers) are adversely affected by the indoor environment.

[50] Ibid p169.

As a result, there are a range of potential costs to the community.

Productivity costs are estimated to be substantial, in the order of hundreds of millions per year in Australia (and perhaps even higher).

Social and health costs are harder to determine but are also estimated to be considerable. Unfortunately, these costs and impacts are out of sight and borne by the individual.

Legal actions are imposing costs on those responsible and have the potential to grow.

The causes of poor indoor air quality are identifiable: poorly designed buildings which rely to heavy on technological solutions; pollutants within the buildings; and poorly designed and maintained HVAC systems.

According to some experts, the impact of poor indoor air quality is a sleeping giant. Unlike the action on the outdoor air, the response has been fragmented and low key.

In the view of the Committee it is time to take stock and change direction.

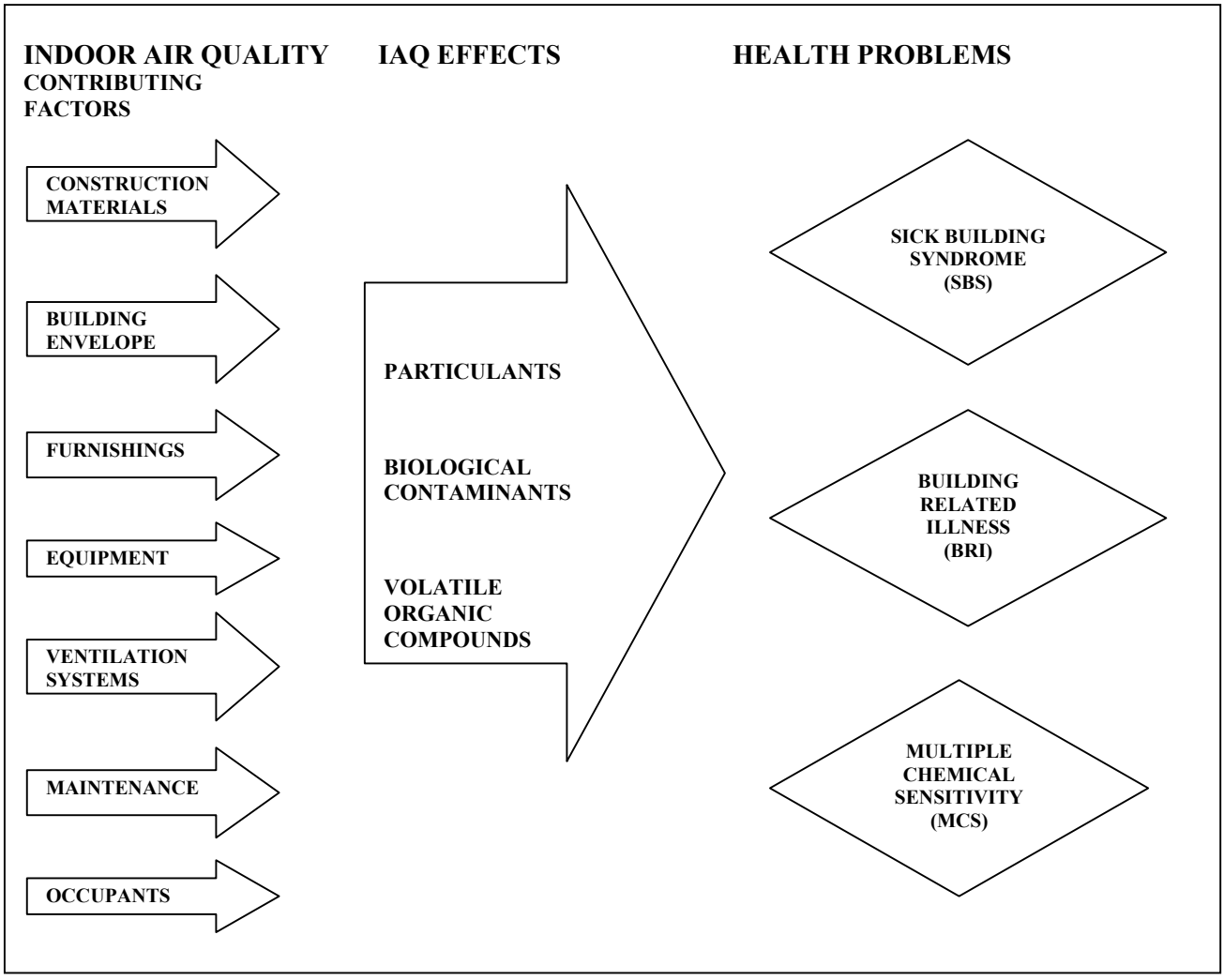
In the next chapter the Committee looks at Sick Building Syndrome, one of a number of recognised health problems associated with indoor air quality.

CHAPTER THREE

Sick Building Syndrome

3.1 What is sick building syndrome?

Over the last 15 years a number of health problems associated with poor indoor air quality have been identified (See diagram below). The identification of health problems such as Sick Building Syndrome (SBS), Building-Related Illness[51] (BRI), and Multiple Chemical Sensitivity[52] (MCS) has coincided with a growing dissatisfaction with and an awareness of the limits of the indoor environment.



3.1.1 Definitions/Symptoms

[51] *Building related illness* (BRI)occurs where specific causal factors have been identified. BRIs are usually characterised by a unique set of symptoms which may be accompanied by clinical signs, laboratory findings, and identifiable pollutants. Hypersensitivity (allergic reactions), infections (such as the well-known legionnaire's disease) and illnesses related to the inhalation of fibres (asbestosis) are all examples of BRI.

[52] *Multiple chemical sensitivity* (MCS) has also been associated with building-related illness. This condition is confined to a small percentage of people with high sensitivity to a number of chemicals in indoor air, which means they are adversely affected when a chemical is present at relatively low concentrations. The existence of MCS is a source of debate in the medical community and has not yet received widespread recognition.

The term "sick building syndrome" was coined in 1983 by the World Health Organisation (WHO) and is currently defined by that body as:

> *the occurrence of specific symptoms with unspecified aetiology, and are experienced by people while working or living in a particular building, but which disappear after they leave it. Symptoms include mucous membrane, skin and eye irritation, chest tightness, fatigue, headache, malaise, lethargy, lack of concentration, odour annoyance and influenza symptoms. SBS usually cannot be attributed to excessive exposure to known contaminants or to a defective ventilation system. (WHO 2000)*

The World Health Organisation defines "health" as "a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity". This is particularly relevant when considering some aspects of SBS.

The definition does not include minorities of individuals who are unusually sensitive to exposures of indoor contaminants. SBS symptoms do not have clear causes and so are often referred to as 'non-specific' symptoms. There is, therefore, no challenge or clinical test for SBS.

The difficulty in identifying SBS was raised with the WorkCover Authority:

> **Mr GIBSON:** Do you believe the medical profession is educated enough to determine an SBS problem rather than just putting it down to a general health problem, being off colour or the flu?
>
> **Ms ST GEORGE:** The lack of data and lack of notification of workers compensation claims only comes in extreme cases of legionnaire's disease. You must remember that 90 per cent is actually passed off as everyday generalised illnesses. I do not blame it on the doctors. I believe it is an emerging issue and people have not really caught the bull by its horns as such. Most employees think, 'I'm coming down with the flu. My immune system is low' or 'I'm weak, I'm tired'. They are putting it down to something else as opposed to a temperature variation which is causing the lethargy or tiredness.
> That is basically what it starts off with, maybe a runny nose, allergic rhinitis.
>
> You will be surprised that not one of our databases actually says asthma. I could say that asthma would be one of the highest incidences of diseases caused by sick building syndrome, yet no-one claims for asthma because it is passed on as an everyday issue. Also, hypersensitive individuals will tend to be more prone to sick building than the tougher people. Therefore, they will say, 'Oh yes, I'm already an allergic person' and they will put it onto themselves as opposed to their environment. It is hard and that is why it has never been given the status it has now. Therefore, people do not act on anything. I am not saying not act, but the priority has not been given to it.
>
> **Mr DUNPHY:** It is difficult to establish a causal relationship, to say categorically that that was the cause of whatever illness a person may have.[53]

Hedge (1996) summed up the uncertainty associated with the 'diagnosis' of SBS:

> *Buildings with a high prevalence of SBS cases are labelled 'sick' buildings, although there is no standardised method for gauging symptom prevalence and no agreement on criteria which can discriminate between 'sick' and 'healthy' buildings. Regrettably, there is no consensus on the number, pattern, severity, or frequency of symptoms which define an SBS case, on how to measure*

[53] Transcript of Evidence, p20.

> *symptoms, over what time period, or even what symptoms should be measured. There is also no agreement in the criteria for classifying a building as 'sick'.*[54]

Others argue that there are no "sick" buildings, rather there are buildings in which "people experience symptoms of illness". A more correct description might be poorly maintained buildings or buildings "that were designed and built from materials incompatible with human occupations". The occupants of these buildings experience a range of adverse health symptoms which are associated with sick building syndrome.[55]

There is, however, general agreement within the research community that SBS is an occurrence of generalised, non-specific low level illness or malaise experienced by a significant proportion of people in a building, with relief some time after leaving the building.

SBS symptoms occur quite commonly throughout the community, and are shared by a number of common minor ailments. What is clear from the research is that symptoms of SBS include:

- Sensory irritation to eyes, nose and throat manifesting as pain, a feeling of dryness, smarting, stinging irritation, hoarseness or voice problems
- Neurotoxic or general health problems such as headache, sluggishness and mental fatigue, reduced memory, reduced capacity to concentrate, dizziness, intoxication, nausea and vomiting, and tiredness.
- Skin irritation, including pain, reddening, smarting, or itching sensations or dry skin.
- Non-specific hypersensitivity reactions, including running nose or eyes, asthma-like symptoms among non-asthmatics, sounds from the respiratory system.
- Upper respiratory/mucus membrane symptoms
- Odour and taste sensations such as changed sensitivity of olfactory and gustatory senses or unpleasant olfactory or gustatory perceptions.

The fact that these symptoms are so common and may be attributable to any number of causes, makes it very difficult to relate them specifically to SBS.

It follows then that a significant issue in the identification of SBS is the *prevalence* of the symptoms among the occupants of a particular building. That a handful of people experience symptoms which disappear when they leave the building is not proof of SBS; those people may simply be hypersensitive. But where a substantial proportion of occupants suffer those symptoms the building could be regarded as a potential Sick Building candidate.

The issue then becomes one of defining what constitutes a substantial proportion of occupants. The American Society of Heating, Refrigeration and Airconditioning Engineers (ASHRAE, 1998) states that:

> *The term "sick building" is used to describe a building in which a significant number (**more than 20 per cent**) [emphasis added] of building occupants report illness perceived as being building-related. This phenomenon, also known as "sick building" is characterised by a range of symptoms*

[54] Hedge A, Addressing the psychological aspects of indoor air quality, Mr D Rowe, Submission to the Inquiry, No 9.
[55] Building Science Forum of Australia, NSW Division, op. cit. p4.

> *including, but not limited to, eye, nose and throat irritation, dryness ... mucous membranes and skin, nose bleeds, skin rash, mental fatigue, headache, cough, hoarseness, wheezing, nausea and dizziness. Within a given building, there will usually be some commonality among the symptoms manifested as well as temporal association between occupancy in the building and appearance of symptoms.*[56]

At the public hearing, Mr Stephen Brown, a Principal Research Scientist with the CSIRO, agreed with this approach. He told the Committee that the proportion of people affected was the key in deciding whether a building was SBS affected:

> **Mr Brown:** …From my perspective, the sick building syndrome essentially is a group of health effects that you cannot trace to any definite cause but occur at a much higher frequency in a proportion of buildings and have an association with occupancy of those buildings. It is almost a proportion factor. I hope that is clear.[57]

Another witness, Mr David Rowe, also pointed out that the prevalence of symptoms among the occupants of a building was an important part of the SBS equation. Mr Rowe told the Committee that he did not totally agree with the WHO definition of SBS:

> **Mr ROWE:** …If I adopted the WHO definition, all of those buildings [in his SBS survey] would be classified sick. That beggars belief. Quite a lot of buildings are not statistically different from the total population average, a couple are significantly worse — at the 95 per cent significance level — and a number are significantly better than the 95 per cent level. I suggest that, if one were investigating a sick building syndrome complaint and found that the prevalence was above the population average, we should look hard at that case first.[58]

3.1.2 Causes

While there is little doubt that SBS exists as a health problem, there is no unanimity on the causes.

Generally, there seems to be a view that the causes of SBS are multifactoral, including air quality, temperature, lighting, noise, and psychosocial factors such as management attitudes in the workplace, stress and interpersonal relations (Rowe), so that, while IAQ is a major factor in Sick Building Syndrome, other indoor environmental factors also have an impact.

It is also generally, but not totally, agreed that it is a health effect which cannot be traced to a specific cause.

This has led some to define SBS via a diagnosis of exclusion, arguing that if a specific cause can be identified then the problem is not SBS.[59]
WHO regards SBS symptoms largely as a complaint of a sensory nature. For instance, the effect of a number of chemicals irritating the trigeminal nerves in mucous membranes, which as a defence mechanism trigger reflex actions such as sneezing or interruption of breathing.

[56] ASHRAE 1998, Indoor Air Quality: Position Paper, American Society of Heating Refrigeration and Air Conditioning Engineers Inc, Atlanta, Revised 1998, in D Rowe, Submission to the Inquiry, No 9.
[57] Transcripts of Evidence, p1.
[58] Ibid p30.
[59] Kreiss K, 1989, The Epidemiology of Building-Related Complaints and Illness pp 575-592. In, Cone J.E. and Hodgson M.J. (Eds.), op cit.

Others argue that each symptom is linked to a separate factor. For example, eye and nose irritation may be due to allergenic contaminants, central nervous system symptoms to solvent neurotoxicity, skin complaints to photodermatitis from monovalent (artificial) light or irritation from volatile organic compounds (VOCs) and low relative humidity, and odour complaints from contaminants.[60]

The American Society of Heating, Refrigeration and Airconditioning Engineers reported in 1998 that "over the past several years higher energy costs have resulted in the introduction of new building materials, decreased ventilation and decreased air leakage. These trends have contributed to the "sick building syndrome" where specific chemical causes are seldom found."[61]

The authors of the final report on Sick Building Syndrome at the University of Toronto St. George Campus, stressing the relationship between humans and their modern surroundings, make the following observation:

> *[The] findings suggest that something deeper and more complicated than a direct cause-effect relationship is going on. They suggest that the syndrome should rather be seen as a consequence of an unhealthy interaction between the building's occupants and its environment, which may include social factors as well as the building's basic design. The physical and aesthetic characteristics of a building, when combined with particular uses and users may result in an unhealthy dynamic that causes occupants of the building to become sick in its environment. The building is consequently labelled unhealthy, or sick. That is, the sick building syndrome may be seen as a symptom of a larger (psychological, social, or design) problem, rather than a cause in itself.*[62]

It was noted early that the syndrome appears to be more frequently associated with air conditioned than with naturally ventilated buildings.[63] This is a view commonly held among researchers.

Willis states that, "it is no coincidence that the most dramatic cases of indoor air pollution (sick building syndrome) have occurred in those most highly managed environments in which major differences between external and internal air are sought to be technologically achieved".[64]

Mr Brown advised the Committee in evidence that "people in mechanically ventilated buildings tend to have more of a problem than people in naturally ventilated buildings".

A survey of Australian workers in 26 office settings by David Rowe, Honorary Lecturer in the University of Sydney's Department of Architectural and Design Science, lends further evidence to that observation. As he told the Committee at public hearings:

> **Mr ROWE:** ... It is interesting to note that the yellow buildings are naturally ventilated without mechanical cooling or heating. The green ones are naturally ventilated through doors and windows but have supplementary cooling and heating. All of them are below the population average. That is not a unique finding in my data. Other people have observed the same thing all

[60] Hodgson, M.J.1989. Clinical Diagnosis and Management of Building -related Illness and the Sick Building Syndrome." 593-606. In Cone J.E. and Hodgson M.J. (Eds.) op cit.
[61] ASHRAE 1998, op. cit.
[62] Sick Building Syndrome on the University of Toronto St, George Campus Study for the Centre for Health Promotion, Environmental Protection Advisory Committee, and Office of Environmental Health and Safety http://www.cquest.utoronto.ca/env/env421h/HealthyUT/SickBldg/
[63] Finnegan M, Pickering C and Burge P, Building Related Illness in Clinical Allergy 16, pp 389-405, 1984
[64] Building Science Forum of Australia, NSW Division, op. cit. p16.

> over the world but nobody I am aware of has an explanation for it. Naturally ventilated buildings seem to be healthier than air-conditioned buildings.[65]

While by definition SBS is not exclusively related to the operation of air conditioning units, the appearance, or at least the recognition, of SBS coincided with a deliberate campaign to reduce energy use during the energy crises of the 1970s and 1980s. Air conditioning systems were used less often or at below capacity. In the US, circulation of air in office buildings was reduced by up to 80 per cent. The result was a reduction in fresh, ambient air. With poor circulation within the building, the door was left open to the many pollutants, bacteria, mould, and mildew that commonly reside in indoor as well as outdoor environments. Coupled with continuing attempts to isolate the indoor from the outdoor environment, indoor air quality deteriorated further.

Recent evidence suggests that air conditioning systems do play a significant contributory role in SBS, through biological contamination. The American Industrial Hygiene Association has claimed that "a substantial proportion of building-related illness and SBS in the non-industrial workplace is the result of exposure to biological contaminants".[66]

It has been shown that in mechanically ventilated office buildings particulates comprise ash, mineral fibres, bacterial substances (endotoxins) and fungi, with high concentrations of endotoxins and fungi in the offices and residual dust. These concentrations have been shown to be very good predictors of SBS.[67]

Some researchers have argued that "SBS could be a non-specific airways inflammation related to organic dust exposure". Organic dust can affect immune cells "even at low levels of exposure".[68]

Others also favour microbiological factors and the role of HVAC systems. According to one, "airborne dust, allergens and micro-organisms can be a significant factor in IAQ, and combined with poor humidity levels may result in significant SBS symptoms being experienced".[69]

It has also been asserted that "a major physiological cause of SBS is airborne potentially allergenic dust produced by air conditioning equipment. Recorded sicknesses are probably caused by inhalation of various types of organic material under conditions of occupational stress. The actual organic material inhaled need not be living bacteria or fungi but simply the products or detritus from them. Air conditioning systems offer growing sites, dispersion mechanisms and distribution.[70]

Related to this is that physical factors such as temperature and lighting intensity can cause increased susceptibility of individuals to immunologically active particles through increased stress activity.[71]

3.1.3 Psychosocial Factors

One of the factors which seems to set SBS apart from other IAQ health problems is the psychological element in the response of occupants. In this perception can play an important role.

[65] Transcript of Evidence p32.
[66] Dombrowsky Y and Hill J, Health Complaints in Air Conditioned Buildings – Based on an Analysis of Existing Scientific Data about Sick Building Syndrome, AIRAH International Conference, 1998
[67] ibid.
[68] ibid.
[69] Building Science Forum of Australia, NSW Division, op. cit. p35.
[70] Dombrowsky Y and Hill J op cit.
[71] ibid

Again HVAC systems play a key role as they are regarded as "the most important contributors to the human perception of poor air quality".[72]

It has been demonstrated that when the immune function is decreased through stress, indoor air pollution has affected the psychology of building occupants.[73]

Psychosocial factors, such as management attitudes in the workplace, stress and interpersonal relations; lack of indoor environment control by occupants due to centrally controlled heating ventilation and air conditioning systems and the inability to open windows, can affect a worker's sense of control over his or her surroundings.

The current management arrangement of the internal environment is that "building operation and maintenance decisions are made by remote decision makers. Building occupants have no control over their immediate environment.[74]

Evidence of this has been found when building management action to address air quality complaints fails to find a cause. Occupants have nonetheless reported the "problem" to be resolved.[75]

In his NSW survey, David Rowe sought responses from occupants of a number of buildings, mostly in the Sydney CBD or inner suburban locations.

Rowe's analysis of the database suggests

> *.. that perceived air quality is a vector of central importance with substantial direct relationships with self-reported SBS symptom prevalence, self-assessed effect on performance of work and overall perception of comfort and satisfaction. An indirect influence on them can also be attributed to thermal comfort, one of the more common areas of complaint in modern office buildings. The word 'perceived' is used in relation to air quality because it is often difficult to measure a direct physical link between occupants' perception and the actual contaminant levels in the air"*[76]

This last point is important.

Rowe's analysis is consistent with other research which suggests there is a possible causal link between *perceived* air quality levels and the prevalence of SBS symptoms. Conversely, a high incidence of symptoms in a group may heighten awareness of factors that affect judgement of air quality. Thermal discomfort may lead to concern about IAQ which, in a modern air conditioned building, is controlled by a poorly understood mechanical system over which the person has no control.[77]

Rowe argues that people try to find reasons for causes for their ailments. It is tempting for individuals to conclude that a general symptom such as headache or lethargy in the afternoon might be caused by the 'stuffiness' of the air rather than a heavy lunch or general tiredness. Discussions with colleagues spread the idea until a significant proportion of building occupants is convinced that the building is

[72] ibid
[73] ibid
[74] Building Science Forum of Australia, NSW Division, op. cit. p14.
[75] Ibid p4.
[76] D. Rowe, Submission to the Inquiry, No 0
[77] ibid

'sick'. Specific, one-off events such as a move into new premises, renovation of occupied space or perhaps an unusual odour may also trigger an 'outbreak'.[78]

But as Rowe and others point out, none of this means that IAQ or lighting or acoustical environment or workplace stresses may not be contributing or even major factors. Nor should it lead to the conclusion that the problem is merely "psychological" and will go away if ignored. Management must takes seriously workers' concerns over such matters, and deal openly with the problem. Lack of action on management's part will confirm workers' suspicions that something is wrong, and the problem can only escalate.[79]

Before looking at ways in which these causes can be addressed, the Committee looks at the impacts of SBS and the regulatory framework currently in place which provides the framework for current control of Indoor Air Quality and Sick Building Syndrome.

3.2 Impacts of Sick Building Syndrome

3.2.1 Costs of SBS

The Committee pursued the issue of the economic costs of SBS at the public hearing. The response of witnesses confirmed the difficulty in precisely identifying the costs. Estimates of the costs generally related to the broader issue of Indoor Air Quality and associated productivity losses.

The issue of productivity costs is vitally important because the costs of occupants are by far the largest over the life of a building.

In 1980, a Commonwealth Department of Housing and Construction study found that the total cost of employees (including salaries) was far greater in life cost terms than the initial capital cost to construct accommodation and ongoing operational expenses. Based on life cycle cost studies for typical office buildings over a 50-year period, the study showed that approximately 92 per cent of total life costs could be attributed to employees. Operational costs including maintenance, cleaning and replacement accounted for 6 per cent of total life costs and the initial capital cost was only around 2 per cent.
Any productivity loss through illness to occupants would be a significant cost and that cost will be related to the incidence of SBS.

The CSIRO advised the Committee in its submission that

> *Overseas research suggests SBS incidence of 40-60% to be common for office environments (Sundell 1996); at present the best we can say for Australia is that our limited knowledge is consistent with this incidence.*[80]

David Rowe from Sydney University has been gathering data on IAQ in Sydney office buildings over the last six years. He has collected data on 26 office settings involving some 1,200 respondents so far.

The questionnaire required respondents to indicate on a scale from 1 (never) to 5 (daily) the frequency of the occurrence of eight symptoms typical of SBS. Thus a score of 8 would indicate that the person never had any of the symptoms while a score of 40 (extremely rare but present) would indicate onset of all symptoms daily. On this basis a score of more than 20 would indicate occurrence

[78] ibid
[79] ibid
[80] S. Brown, Submission to the Inquiry, No 5

of several symptoms more than once a week. Overall, 32 per cent of the respondents reported scores above this level.

The data show that 5 per cent of respondents reported never experiencing any of the eight symptoms listed and 47 per cent reported them as generally infrequent, leaving 48 per cent with moderate to very frequent experience.

Thirty-six per cent of respondents to the survey perceived air quality in their workplace as less than fully satisfactory and 30 per cent believed their work performance was adversely affected by the indoor environment.[81]

Studies have shown that buildings with good overall internal environmental quality can increase worker productivity by between 6 and 16 per cent.[82].

However, it seems few experts doubt that the cost is substantial, even if one assumes a modest percentage of building occupants are affected by SBS:

> **Mr HICKEY:** What would be the cost benefit of the reduction in pollutants in indoor air? When you say 40 per cent to 60 per cent of people are affected by indoor air quality, have you any idea of the benefit on sick days, downtime in work, et cetera? Have you any idea of that?
>
> **Mr BROWN:** It is all estimates, but I can give you some idea. In the United States a detailed study was made of indoor air quality in general on the health and productivity cost in America. On the basis of that it was estimated what the cost was. It came to somewhere between 0.3 per cent and 2 per cent of gross domestic product. If we were to translate that same factor to the Australian economy, the annual cost of poor indoor air would be between $1.7 billion and $11 billion. That is assuming we have the same experience and the same problems. One big difference is that the United States study factored in radon exposure. We do not seem to have a radon problem in Australian buildings.
>
> Another way to estimate it was to look at the number of workers in offices and what proportion are affected. I made a calculation for one of our State of the Environment Reports on human settlement that is being written at the moment for Environment Australia. We assume four million people working in non-industrial environments. We assume their average salary. We assume that 30 per cent of those people would lose 6 per cent of their productivity due to poor indoor air. There have been some studies of people in artificial environments where they are exposed to some building materials and that sort of thing, and they found those levels of productivity loss. The productivity loss based on those numbers is $2.9 billion a year. So, it can be a significant factor to the economy, if those figures are real. Unless we do a good questionnaire survey of the experience of our own office occupants, we cannot be more definite than that. We have to rely on this guesswork and estimates.[83]

Mr Rowe told the Committee in evidence,

> **Mr ROWE:** …assuming there are 100,000 public servants working in office buildings in the State—I do not know whether that number is right but it would be within that ballpark—and that you lift their productivity by one per cent, that is $40 million a year.[84]

[81] D. Rowe, Submission to the Inquiry , No 9
[82] Romm J, Lean and Clean Management, 1994
[83] Transcript of Evidence, p6.
[84] Ibid p33.

And, as Mr Rowe points out in his submission,

> *[i]t is difficult to estimate productivity in most modern office situations because, unlike process workers in manufacturing industries, office workers usually do not produce a measurable product.*[85]

3.3 How SBS affects different building types

While most studies of SBS have focused on office buildings, SBS does have ramifications for almost all indoor environments, including houses and schools. All building types have many of the contributing factors that are associated with SBS. However, different building types have different problem areas. These factors are summarised below:

1. Houses

- Residences near the coast (humid) are affected by house dust mites.
- Up to 70,000 Australian houses were insulated with urea formaldehyde foam insulation which outgasses formaldehyde.
- Houses with chemical pest treatments.
- Tobacco smoke.
- Modern houses without air vents have the potential to be closed up too 'tightly' to allow pollutants to escape.
- Nitrogen dioxide emitted from unflued gas heaters and stoves.
- Pollutant emissions from building materials and furniture.

2. Schools

- Nitrogen dioxide emitted from unflued gas heaters. There is currently a program to replace these heaters with low emission heaters. However, the replacement heaters are still unflued and may still emit excessive levels of nitrogen dioxide (Stephen Brown, CSIRO).
- Volatile organic compounds outgassed from building materials, usually from reconstituted wood products, adhesives, and flooring.
- Pollutant emissions from building materials and furniture.

3. Recreational buildings

- Tobacco smoke
- Pollutant emissions from building materials and furniture
- Problems due to design of HVAC systems and their operation and maintenance.

4. Offices

- Problems due to design of HVAC systems and their operation and maintenance.
- Build up of pollutants due to low outside air ventilation rates
- Pollutant emissions from building materials and furniture and office appliances
- Poor daylighting (ie lack of sunlight)
- Lack of occupant control over HVAC systems

Comment

While there is neither total agreement among experts on the exact definition of or causes of SBS, there is little doubt that it is a significant health concern brought on by human interaction with the artificial built environment.

[85] D. Rowe, Submission to the Inquiry, No 9

It is important to remember that by attempting to artificially shut ourselves off from an unhealthy external environment it is highly likely that we will experience both psychological and physiological effects within the newly created artificial environment.

The Committee received no submissions that Sick Building Syndrome was not a genuine health concern.

Reputable sources around the world regard it as a real and significant problem.

There is considerable evidence that a significant proportion of office workers are affected by poor indoor air quality and SBS.

People spend between 70 and 90 per cent of their time indoors. Given that indoor air can be more polluted than outdoor air, the indoor environment is an important factor affecting human health.

The CSIRO has a dedicated program looking specifically at indoor air quality issues. Evidence from Dr Brown, who works in that unit and is a highly regarded expert in the field, left no doubt that SBS was a health problem that needed to be addressed. In fact, Dr Brown noted how timely the Committee's inquiry was.

There is in fact a wide consensus that the internal environments are harming our health and sense of well-being. This is particularly the case for children.

Workers — in particular those in a work environment where they have little control —become sensitive to the air quality problems in the building and other systems over which they have little control.

The likely main causes of SBS are:

- **Poor Indoor Air Quality, including**
  - **Poorly installed and maintained HVAC systems;**
  - **Indoor pollutants**
- **Poor environmental building design (over dependence on technology)**
- **Psychosocial factors (stress; management attitudes; interpersonal relationships, lack of personal control etc)**

A particular concern is the contamination of HVAC systems.

The costs to the government, as a major employer, may be very significant indeed. All indications are that those costs run into millions of dollars at least. The cost to the community is potentially much greater.

From a financial perspective (ignoring health and social issues), estimates of productivity losses in the order of millions, if not billions, of dollars should be of concern to governments and other employers.

In fact the cost implications of lost productivity, health problems and potential legal action justify the action on addressing Sick Building Syndrome.

Upfront investment on the indoor environment in the design and construction of new buildings could also yield significant benefits, including significant savings, in the future

Considering an agency's most significant financial commitment is to its employees, provision of a good indoor environment and the rectification of IAQ and SBS issues may in the future become a financial imperative for all government agencies and, indeed, businesses.

From the evidence in the above two chapters it is clear that strategies to deal with IAQ will also deal significantly with SBS. However, it needs to be acknowledged that there are other factors at work in SBS (such as psychological and indoor environmental issues such as lighting and temperature) which will need to be considered in specifically addressing SBS problems.

It is important that occupants not only suffer no preventable illness inside buildings but they experience a positive sense of wellbeing.

The committee now outlines the regulatory framework for SBS.

3.4 Regulatory Framework

In New South Wales there are numerous instruments which aim to regulate aspects of Indoor Air Quality. They range from the enforceable, such as legislation and contracts through standards (enforceable as regulations) to guidelines and codes of practice which are voluntary and perhaps only enforceable through Duty of Care obligations.

The mechanisms which form a regulatory framework for Sick Building Syndrome in Australia are listed below:

- Common Law
- Legislation
- Regulations
- Codes of Practice
- Australian Standards
- Other standards, guidelines and recommendations.

These instruments form a vague and manipulatable web which is not easy for many practitioners to apply.[86]

A range of federal and state legislation imposes responsibility on building owners, managing agents, contractors and others to provide safe environments in the workplace, not only for employees but for anyone entering the premises. If they fail to do so there is an issue of liability and the costs associated with it.

A number of Codes and Standards deal with building construction and management relating to SBS and IAQ issues as do a number of guidelines and codes of practice. While they generally do not deal

[86] Building Science Forum of Australia, NSW Division, op. cit. p51.

specifically with SBS, they can impact indirectly on SBS by addressing some IAQ issues, such as air quality or mechanical ventilation.

In addition, there is for those involved in the construction and management of buildings a legal risk inherent in the process. Litigation, liability and legal precedent can ensue through common law avenues.

Those with a potential indoor air quality liability or duties of care are:

- the building owners and managers
- employers or other occupiers of premises
- architects, engineers and others involved in the design and construction of the premises
- manufacturers of relevant equipment; and
- contractors or others involved in the maintenance of the equipment.[87]

Australia is becoming a more litigious society, and there would seem to be scope for workers to sue for SBS-related health problems.

3.4.1 Legal Framework

As mentioned above there is a range of legal avenues which have implications, or potential implications for, Sick Building Syndrome.

Unless other approaches are adopted, litigation could well become the driver of change where plaintiffs seek to establish liability in a "chain of responsibility in providing products and services to the public". In this case the liability relates to "professionals dealing with the design, development, construction, sale and management of buildings".

There is a duty of care to take all reasonable steps to see that those who may be affected by their acts or omissions are not put at risk of reasonable foreseeable injury, loss or damage by the way in which they conduct themselves.

IAQ actions to establish liability has occurred in the following areas to date.

- Breach of statutory obligations under workers' compensation and occupational health and safety and, increasingly, environmental legislation
- Torts of negligence or nuisance (common law)
- Occupier's liability
- Strict liability under certain statutes
- Breach of warranty, particularly in relation to new buildings and their services such as ventilation, cooling and heating systems and

[87] Australian Institute of Refrigeration Air Conditioning and Heating, 1997, Managing Indoor Air Quality, A Practical Approach, p2.

- Breach of Trade Practices legislation.

The burden of proof is greater in the common law areas, such as negligence, than in statutory areas such as workers' compensation. As a consequence, most cases decided have dealt with occupational air quality issues.[88]

Legal Precedent
In Chapter Two, the Committee identified a number of cases both in Australia and overseas which could form the basis of legal precedent and claims for considerable damages.

Some of these areas where legal actions could ensue are dealt with in further detail below:

3.4.1.1 (NSW) Occupational Health and Safety Act 1985

The Occupational Health and Safety Act 1985, which is administered by WorkCover NSW, imposes obligations on an occupier of a workplace to ensure that the workplace and the means of access to and egress from the workplace are safe and without risks to health. The clear reference to the "health" of employees in the Act (clause 15) is important in this discussion.

An occupier is a person with the management or control of the workplace. That may vary from part to part of the workplace, and may include not only the employer, but also a landlord and managing agent.

Regulations made under the Act may also impose more precise duties on various parties relevant to the IAQ of premises. For example, the Asbestos Regulations impose duties on employers and occupiers of premises to ensure that the workplace and plant are designed and constructed to be free of asbestos or without risk to health from it. This imposes particular obligations for the assessment and control of risk from asbestos.

3.4.1.2 Common law

The considerations referred to in relation to the occupier's liability provisions apply equally to the common law duty of care. It should be noted however that:

(a) while the occupier's liability provisions relate only to the state of the premises, the common law duty of care is much wider and relates also to the use of the premises

(b) the occupier's liability provisions relate only to an occupier of the premises, whereas the common law duty of care applies also to those involved in the design, construction and maintenance of the premises.[89]

Obstacles identified as hampering common law claims include:

- A lack of conclusive scientific or medical evidence
- The presence of consistent actions to the illness and pre-existing conditions
- The cost of litigation and delays
- The difficulty in proving that a defendant shall have reasonably foreseen the damage that could occur
- The difficulty in proving that a duty of care was owed to the plaintiff.[90]

[88] Department of Health and Aged Care, op cit. pp 167/8.
[89] Australian Institute of Refrigeration Air Conditioning and Heating, 1997, op. cit, p2.

3.4.1.3 Disability discrimination

Federal and State legislation exists which renders it unlawful for a person to discriminate against another person on the ground of the other person's disability.

Under the (Commonwealth) *Disability Discrimination Act 1992*, those making available to the general public or a section of the general public premises and the facilities within them, are also required to provide that same access to people with disabilities. (There are exceptions based on inappropriate design and construction elements and hardship caused by alteration costs.)

In NSW, the *Disability Discrimination Legislation Amendment Act 1998* amends various other pieces of State legislation so as to provide consistency with the Commonwealth legislation.

A NSW nightclub operator was recently found to have breached the disability discrimination provisions. A person with asthma complained of being unable to remain in the nightclub because of the environmental tobacco smoke from fellow patrons. This is an example of IAQ being an element of the provision of access to premises and facilities, providing a potential liability to damages (in this case $2,000) for the occupier. It is not difficult to imagine other IAQ issues which may result in similar liability to the occupier, or to the building owner or manager.

3.4.1.4 Occupier's Liability

The occupier's liability also accrues under the provisions of the Wrongs Act 1958. This imposes a duty on an occupier of premises to take such care as in all the circumstances is reasonable to see that any person on the premises will not be injured or damaged by reason of the state of the premises, or of things done or omitted to be done in relation to the state of the premises. This would seem to relate to IAQ.

A landlord who:

(1) is under an obligation to the tenant to maintain or repair premises

(2) is or could have put himself/herself in a position to exercise a right to enter on the premises to carry out maintenance or repairs

would be considered an occupier of premises owing this duty of care

In determining whether or not the duty of care has been discharged, a number of factors are set out in the Act which relate to:

- the gravity and likelihood of the probable injury
- the nature of the premises
- the characteristics of the person entering the premises and their ability to appreciate the danger; and
- a balance of the burden eliminating the danger compared with the risk of the danger to the person.[91]

[90] Department of Health and Aged Care, op cit. p168.
[91] Australian Institute of Refrigeration Air Conditioning and Heating, 1997, op. cit, p1.

3.4.2 Codes and Standards

The Department of Health and Aged Care report expressed concern at the lack of focus in dealing with the problem of IAQ at the administrative level in Australia. It noted that "the fragmented nature of the Australian response is reflected in the poor integration of policy 'products'". These 'products' included Standards, Codes of Practice, Guidelines, exposure standards, guidance notes and reports. It went on do identify some 21 of these 'products' in all. According to the report, the products "suffer from the lack of a clear, unifying framework within which to operate".[92]

The Committee looks at some of these 'products'.

3.4.2.1 Building Code of Australia

The Building Code of Australia (BCA) is a national building code that has been adopted into building regulation by all States and Territories. The BCA is produced and maintained by the Australian Building Codes Board on behalf of the Commonwealth, State and Territory Governments.

The code makes no specific mention of IAQ nor does it address many of the factors which contribute to sick building syndrome. It does, however, make some specific performance provisions for the internal environment, mainly in relation to ventilation with outdoor air.

The BCA is underpinned by three principles one of which, in part, is: "to safeguard people from possible injury, illness or **loss of amenity**…" [emphasis added]

Furthermore, the following objectives of the Code are relevant:

- Safeguard occupants from injury, illness or loss of amenity due to —
  - isolation from natural light; and
  - lack of adequate artificial lighting
- Safeguard occupants from illness or loss of amenity due to lack of air freshness.

The BCA then contains technical provisions for the design and construction of buildings and other structures, covering such matters as structure, fire resistance, access and egress, fire-fighting equipment, mechanical ventilation, lift installations, and certain aspects of health and amenity.

In 1996 a performance-based BCA (BCA 96) was released in place of the more prescriptive 1990 version. Some of the advantages of the performance-based approach identified were:

- Allowing the use of alternative materials, forms of construction or designs
- Innovative use of materials, forms of construction or designs
- Permitting designs to be tailored to a particular building.

Clause 3.4.3.4 (d) (i) specifies a formaldehyde emission limit for particleboard structural sheet flooring.

The BCA is utilised by local government authorities as a benchmark for building design. The Code is incorporated into local government regulations for the purpose of building design procedures.

[92] Department of Health and Aged Care, op cit. p162.

3.4.2.2 Australian Standards

Standards Australia is the body responsible for the publication of most standards in Australia. According to the Australian Building Code Board, the two bodies have agreed to a Memorandum of Understanding which has enabled industry to operate with greater certainty, particularly as a result of coordinated publishing of standards and BCA amendments.

There are no Australian Standards which specifically address SBS. As with the BCA, Australian Standards deal with the issue in an implicit fashion. For example, there are Standards which deal with ventilation codes and conditions such as legionnaires disease. The most relevant are identified below:

AS 1668.2:1991, Mechanical ventilation for acceptable indoor-air quality.

The scope of this standard is defined as follows:

> "This Standard sets out requirements for air-handling systems which ventilate enclosures by mechanical means, where such systems are required by a Regulatory Authority. It sets minimum requirements for preventing an excess accumulation of airborne contaminants, or objectionable odours. These minima are based on needs for body odour control, food odour control, air contaminant control, or carbon dioxide concentration or a combination of any or all of these factors, depending on the particular situation. It does not prescribe other requirements associated with comfort, such as temperature, humidity air movement and noise."

The scope is achieved by prescribing:

- The amount of outdoor air necessary to maintain indoor air at an acceptable quality
- Locations for outdoor air intakes to prevent contamination
- Exhaust ventilation requirements for enclosures in which contaminants are generated
- Carpark, loading dock, automotive service, and ventilation requirements.

AS 3666.1:1995, Air-handling and water systems of building — Microbial control Part 1: Design, installation and commissioning

The scope of this standard is defined as follows:

> "This Standard specifies minimum requirements for the design, installation and commissioning of air-handling and water systems of buildings, other than sole occupancy dwellings."

The scope is achieved by prescribing:

- Location and design of air intakes
- Location and design of air outlets from the building
- Requirements for air filters, humidifiers, evaporative coolers, coils, trays and sumps, condensate drainage, fan assemblies, ductwork, terminal units and commissioning (refer AS 3666.2)

AS 3666.2:1995, Air-handling and water systems of building — Microbial Control Part 2: Operation and maintenance

The scope of this standard is defined as follows:

> "This Standard specifies minimum requirements for the operation and maintenance of air-handling and water systems of buildings, other than sole occupancy dwellings."

The scope is achieved by prescribing:

- Servicing of plant, equipment and components
- Easy and safe access for cleaning, inspection and maintenance
- Provisions in the system to facilitate maintenance
- Operating and maintenance manuals
- Maintenance records.

WorkCover summarised the issue in hearings as follows:

> **Mr DUNPHY:** Australian Standard 1668 talks about mechanical ventilation and air-conditioning in buildings and the requirements for air handling and how buildings should be ventilated ….The other Australian standards that relate to legionnaires disease are Australian Standard AS/NZS 3666, which relates to the air-conditioning and water systems for microbial control, and Australian Standard 3896, which is to do with water examination for legionella. It suggests procedures for that. They are the only Australian standards of which we are aware that relate directly to indoor air quality and sick building syndrome that relate primarily to legionnaire's disease.[93]

AS/NZS 1859 Reconstituted Wood Based Panels
Specifies limits on formaldehyde emissions from particleboard

3.4.3 Other relevant tools

- *National Occupational Health and Safety Commission*: Exposure Standards for Atmospheric Contaminants in the Occupational Environment
- *National Health and Medical Research Council*: Indoor Air Quality Goals
- *BOMA*: Guidance Notes – Managing Indoor Air Quality

Comment
There is currently no specific or focused regulatory framework for the management of indoor air quality and the prevention of sick building syndrome.

A number of the standards and codes which have evolved have relevance for SBS issues. However, they appear to be ad hoc, lacking a comprehensive perspective, and are not underpinned by clearly articulated and strategic policy objectives. There is even some doubt as to how well the standards are monitored or implemented.

The development of legal actions on Indoor Air Quality and Sick Building Syndrome coupled with the absence of a policy framework to deal with the issues has significant implications. Ultimately those who feel aggrieved by health problems will seek redress in the courts which in turn will drive policy. It becomes the driver for change.

[93] Transcript of Evidence, p18.

As shown in Chapter Two, there are possible precedents for workers taking legal action against employers for IAQ-related illnesses, which might include SBS, as judges appear prepared to make a causal connection provided there is sufficient evidence presented to them.

Legal action is potentially costly to employers, both in legal fees and compensation settlements.

While OH and S is a tool which can be currently utilised to addresses some of the IAQ problems, the resort, initially, to enforcement approaches to such a wideranging and significant problem is unsatisfactory. Of course, many buildings are not workplaces and would fall outside OH and S legislation.

It is in the interests of the whole community to avoid resolving the issue in such a legalistic way. A more comprehensive, strategic and cooperative approach is needed to address the fundamentals of the problem

It is far better to meet the challenge now by acknowledging the problem and developing solutions.

The Committee looks at a range of options and makes recommendations in the next chapter.

CHAPTER FOUR

Minimising SBS in the Future

4.1 Introduction

It is clear from the preceding chapters that, while the causes of SBS cannot be precisely identified, it is considered by a many experts in the community to be one of a number of significant health problems stemming from poor indoor air quality.

The potential cost to the community, in terms of health, quality of life, lost productivity and possible legal action, warrants action to deal with the problem, in the view of the Committee.

In considering the need for action on SBS (and indeed poor IAQ) it is worth reflecting on the "do nothing" option as described by the Department of Health and Aged Care. The report stated that, in doing nothing,

> *... it can be foreseen that little by way of recrimination would occur in the next few years. Perhaps a few court cases might see a legal precedent set. If a government was unlucky, the case may be brought and won against them, which means compensation would be due and short term embarrassment high.*
>
> *In the mid to longer term, the insidious nature of air quality will continue to impose its hidden cost burden on the community as a whole. Many peoples' lives will be of lower quality than they might have been; a number of lives will have been shortened by two or three years. Financially, the nation will spend greater amounts on health care than would otherwise be the case.*
>
> *Should future administrations choose to act to improve indoor air quality, they will find the financial cost of retrieving the position will be higher than if the previous administrations had initiated mitigation policies.*[94]

The Committee is in no doubt that SBS is a genuine problem facing occupiers of buildings and is a cause for concern. While the extent of the problem is not fully quantified in Australia, the Committee feels strongly that it is time to address the adverse impacts of a poor indoor environment.

Accordingly, the Committee has made a number of recommendations which address the broader issue of indoor air quality and, where possible, the specific issue of Sick Building Syndrome.

While it is acknowledged that further research in the Australian context is needed, there are a number of strategies which can be set in train immediately that will reduce SBS. In fact, the HAC report cautions against stalling while awaiting further research, stating that:

> *There is, however, a tendency for policy development to mark time, waiting for 'more research'. The argument goes something like – more research, means more accuracy, means better policy. While the logic is sound, the actual process moves quickly into the realms of diminishing returns, where policy development is held over pending research that merely adds a token of polish to existing robust knowledge".*[95]

[94] Department of Health and Aged Care op cit, p17.
[95] Ibid, p12.

Because the causes of this health problem are multifactoral "….the ability of health professionals and administrators to improve health outcomes remains limited…. More often than not, decisions affecting health outcomes are made elsewhere, by those involved in, say, infrastructure development, transport planning and building/construction codes".[96]

Solutions, therefore, need to come from a range of disciplines and directions.

Comment

The Committee is of the view that poor air quality is unacceptable whether it be outdoor or indoor. Governments need to address poor indoor air quality through a range of policy options with the same determination that it is addressing outdoor air pollution. It is a public health issue.

The Committee does acknowledge that poor indoor air quality and SBS are complex problems and, therefore, there are no simple solutions.

Accordingly, solutions will need to be cross portfolio, cross-jurisdictional and require varying timeframes to implement.

In considering solutions to the problem it must be remembered that to a considerable extent the problem has been caused by an over dependence on technology. The solutions therefore will not be a simple technical solution. Rather, an holistic approach which is mindful of the relational effects of the causes must be adopted and which calls on the expertise of those from a range of fields.

Given that employee costs far outweigh the building and running costs of offices, it is in the interests of building owners, managers and employers to invest to ensure the creation of optimum internal environments.

Not only will this result in improving staff health and well being, it will save the Government money by improving productivity and reducing energy consumption and operating costs.

It would seem, in fact, that, while the costs of SBS are high, the costs of remediation and improved building design are comparatively low. One study has estimated that the benefits of improving indoor environments exceed costs by a factor of 18 to 47.

In identifying a range of solutions to these problems, the Committee will address five areas in particular:

1. **Responsibility for indoor air quality**
2. **Need for further research**
3. **Prevention of SBS/poor IAQ in new buildings**
4. **Management of existing buildings**
5. **Education**

[96] Ibid, p24.

4.2 Indoor air quality: whose responsibility?

From the outset, the most important issue to resolve regarding IAQ is just who should have administrative responsibility for it.

As the State of the Environment's report *Indoor Air Quality* points out:

> *Regulatory actions related to indoor air quality are limited, especially in comparison to regulation of outdoor air quality and industrial workplace air - a feature also common overseas. While some guidance has been provided by authorities such as the National Medical Health and Research council and the National Health and Safety Commission, there is a need for a more structured approach to evaluation and control of indoor air quality. A severe limitation is the absence of a single government authority with responsibility for indoor air quality.*[97]

Stephen Brown (from the CSIRO), also referred to the failure to identify a responsible authority for IAQ issues in Australia:

> **Mr BROWN:** I believe we need a more structured, systematic and planned approach to dealing with the issues. At the moment it is being dealt with by the CSIRO through my project. It is being dealt with by some universities through research projects, and by the manufacturers to some degree as they feel they can afford to make changes in their products, I guess. In the meantime we have confusion about whose responsibility it is. Should it be in the building code or should it be something that the Environment Protection Authority addresses, as happens in Europe and America, or is it something that the health regulations should address? The situation is quite confused. It needs someone or some way to integrate those different parties that have a role to play and are affected by what is happening to get some co-ordinated effort.[98]

The Total Environment Centre observed in its submission that:

> *Currently no single government authority, in any jurisdiction, has responsibility for IAQ. In contrast to the outdoor air environment, no regulations have been developed specifically for indoor air environments. A report commissioned by the Advisory Committee on Air Quality for the Australian and New Zealand Environment Council (ANZEC) and the NHMRC in 1990, confirmed that responsibility for indoor air, in both public and domestic situations, lay with the states.*[99]

From the outset of this inquiry, the Committee experienced for itself the lack of clear focus and responsibility within state agencies on this issue. Agencies which the Committee expected to have an interest in IAQ/SBS issues made little or no contribution to the inquiry.

For example, the Environmental Health Section of the Department of Health declined to make a submission to the inquiry, even though it was specifically contacted by the Committee secretariat to do so and despite the Committee's understanding that the Department was undertaking a study into IAQ.[100]

Likewise, the Committee was surprised that the Environment Protection Authority did not wish to make a submission, referring the Committee instead to the WorkCover Authority. Yet the EPA's

[97] Brown, SK, Indoor Air Quality, State of the Environment Australia, Technical Paper Series, Atmosphere, 1996, p9.
[98] Transcript of Evidence, p5.
[99] Total Environment Centre et al, Submission to the Inquiry, No7.
[100] Immig J, Rish S, Brown S, Indoor Air Quality Guidelines for Sydney Olympic Facilities, op cit, p6

charter includes, as one of the agency's key objectives, the aim "to reduce the risks to human health and prevent the degradation of the environment".[101]

The WorkCover Authority (the state agency responsible for the Occupational Health and Safety Act) made a submission only after receiving a specific invitation and encouragement from the Committee.

Mr Smithies from the Department told the Committee at public hearings of the Department's difficulty within DPWS in assembling SBS specific information for the Committee:

> **Mr SMITHIES:** …Having said that, when one considers the diversity of the role of the Department of Public Works and Services and its activities, it is a challenge to say who within an organisation of 2,700 people could be brought to this Committee today to provide the Committee with an insight into all those roles. That is why I have brought three colleagues with me. When we get into the detailed questions, we will probably start to get into technical areas. Chris Oh will be able to speak in terms of ecologically sustainable development. He is probably one of the best placed people in New South Wales to be able to speak about its concepts and application. He is well recognised in Australia—likewise my counterparts towards the other end of the table. They are very up on how to manage building stock. With those introductory remarks, I will leave the proceedings to the Committee.[102]

The need for strategies across jurisdictions was also brought to the Committee's attention.
One submission, for example, recommended that

> *Strategies should be developed in tandem with Commonwealth initiatives such as the Air Pollution in Major Cities Program, which identifies the development of national standards, implementation strategies, monitoring, research and community education as the five major areas requiring attention.* [103]

Comment

One of the reasons for the success in tackling outdoor air pollution is the clearly defined roles and responsibilities for the task. Such roles and responsibilities have not been identified with regard to indoor air quality, an issue which potentially has considerable health, financial and social implications for the community.

As well as the immediate health implications, there are also cost implications for government.

The Committee is disappointed that some government agencies, which it would expect to have an interest in indoor air quality issues from a public health and environmental perspective, saw fit not to contribute to the Committee's investigation.

The lack of coordination and an accompanying policy vacuum has an inherent risk. The whole process could become driven by legal action as affected individuals and groups take matters into their own hands.

In the Australian federal structure the environment is a state issue. While some of the matters discussed below would benefit from a coordinated national approach, New South Wales

[101] Environment Protection Authority, Annual Report, 1997/98
[102] Transcript of Evidence, pp39/40.
[103] Total Environment Centre et al, Submission to the Inquiry, No 7.

should be able to take positive and direct action itself on these areas it can. Others issues should be pursued in the appropriate forum.

A multi-disciplinary approach by one focused group is needed to coordinate the public health, the occupational health, environmental, building infrastructure and procurement aspects of indoor air quality.

Once responsibilities are clearly established at the State level, cross-jurisdictional strategies can be pursued.

Given the range of issues which need to be considered the Committee feels that a whole of government approach is needed to address the problems and implement the strategies identified in the following sections. A state government inter-agency working group seems the best approach. It should ensure input from all stakeholders, including the private sector, where appropriate.

RECOMMENDATION ONE

THAT the Government establish an Inter-Agency Standing Committee (IASC) to provide a strategic approach to indoor air quality issues, including Sick Building Syndrome, in New South Wales. The Standing Committee should:

- **Include (but not be restricted to) the following agencies: Government Asset Management Committee (Premiers Department) EPA, DPWS, Dept of Health, WorkCover and SEDA;**
- **Be responsible for implementing the recommendations of this report (including raising the issues at appropriate national forums); and**
- **Initially be funded with a seed grant from Treasury. It should then operate on agency budgets as these agencies have been identified because the issue forms part of the core business of each agency.**

4.3 The need for more research

As was outlined above, it is generally agreed that there is a lack of specific information on the extent of SBS in NSW (and Australia).

The Department of Health and Aged Care notes that "in comparison with the United States and Europe, Australia has a limited research base specifically examining BRI and SBS issues". This area does not have the high profile of other research areas and as a result "there is no nationwide coordination of effort".[104]

The report also notes that, while there were some potential sources of data, these were difficult to access. For example, building owners and managers, a major source of such information, generally did not make it available, for "legal and/or commercial reasons." What research there is, is skewed to the work environment and public facilities for legal reasons with little attention being given to the home environment.[105]

[104] Department of Health and Aged Care, op cit. p23.
[105] Ibid.

The CSIRO Division of Building, Construction and Engineering has done quite extensive research into IAQ, with many significant findings. The CSIRO considers indoor air pollution to be an issue of sufficient importance to warrant major ongoing research projects in this area.

Stephen Brown (CSIRO), in his submission to this inquiry, argues that there is a need for a systematic study of SBS in Australia:

> *A standard questionnaire has now been developed by UK researchers (Raw 1995); application to such a randomly selected population in Australia would allow incidence to be better determined and this has been recommended by Environment Australia as an Environmental indicator for human settlements.*[106]

He told the Committee that, "unless we do a good questionnaire survey of the experience of our own office occupants, we cannot be more definite than that. We have to rely on this guesswork and estimates."[107]

Mr David Rowe has also argued that further research needs to be done in this area. He outlined a proposal for a two-stage, wide ranging survey. The questionnaire used in Mr Rowe's previous research would be reviewed and extended by addition of questions designed to measure characteristics of the psychosocial environment of respondents.

The project would involve about 5,000 workers in some 100 State-owned and leased office premises in metropolitan and regional locations.

The first stage would quantify the extent and prevalence of SBS symptoms in a large sample of NSW public sector offices.

The second stage would examine in more detail the subjective responses of building occupants together with measurement of all physical variables that are thought to influence the incidence of SBS symptoms in order to identify relationships between physical variables and subjective comfort vectors.

Outcomes of study.

Stage One would provide:

- A reliable indication of the extent and severity of SBS and related problems of comfort and satisfaction in the NSW Public Service and, by extrapolation, the NSW community at large
- A reliable and reasonably accurate measurement of the extent of problems in particular buildings in comparison with a large population sample.

Stage Two would provide

- A solidly based view of the effects of physical parameters on occupants' comfort and satisfaction, and the effect on performance of work and health in the workplace as related to the experience of working in a variety of indoor environments
- A more refined instrument for measuring the performance of problems buildings

[106] S Brown, Submission to the Inquiry, No 5, Attachment 2, State of the Environment Indicators
[107] Transcript of Evidence p6.

- A simple and reliable software model for use in assessing new rental accommodation and briefs for new construction.

Comment
While the Committee agrees that action needs to be taken immediately on IAQ and SBS problems, it is aware of the limitations of knowledge regarding specific SBS issues. There is still some uncertainty around the specific causes and, particularly, the extent of the problem.

To deal with aspects of the problem properly, the government needs more than best guesses. The Committee is of the view that further research is indeed required if our understanding of SBS is to be progressed.

The issue of SBS has implications for both the private and the public sector. Both sectors should contribute to the research.

RECOMMENDATION TWO

THAT the IASC:
1. **identify sources of funding for a research project to precisely identify the extent of SBS in the public sector in New South Wales. The findings would be used to refine strategies identified in the recommendations below; and**
2. **Consider ways to access all relevant data compiled in NSW on IAQ/SBS issues.**

4.4 Improving IAQ and reducing SBS

The recommendation for further research is not an argument for taking no other immediate action. There are a number of strategies which can be implemented directly which will help reduce SBS by improving indoor air quality.

Mr Brown summed this up very neatly at the public hearings:

> **Mr BROWN:** …Until we know what the problem is and what the causes are—but I think the way forward is to realise that the way we are building and operating our buildings at the moment is not optimum. We can improve it. We can have lower emission materials when we construct buildings, when we furnish buildings and what we put into the buildings.[108]

The Committee has identified three strategic areas where action can be taken. These are:

1. New Buildings
2. Managing Existing Buildings
3. Education

4.5 New Buildings

The is no doubt that the causes of the health problems associated with SBS (and poor IAQ) should be eliminated rather than remedied. Indeed, "the logic of prevention rather than cure is rarely disputed".[109]

[108] ibid, p7.
[109] Department of Health and Aged Care, op cit. p24.

New buildings provide the best opportunity to eliminate, or greatly reduce, SBS and the planning and design phase is the best time to address the causes of SBS.

The starting point then should be the design, both the building and the interior design, to ensure a holistic, integrated approach to solving the problem.

The approach needs to be holistic because of the multifactoral nature of the SBS problem and should encompass:

- Ecological sustainable design
- Using only products, equipment and materials with the lowest environmental impact
- Providing occupants with a sense of control over their immediate environment
- Preference for low energy consuming ventilation systems which utilise natural ventilation principles
- All mechanical ventilation systems to be maintained and serviced to a standard which controls microbiological contaminants

4.5.1 Design

The Committee has provided some background in Chapter Two on the history of building design and its relationship to indoor air quality. In summary, the Committee heard that building design has become driven by technology, convenience and short-term planning. There is an automatic recourse to technological solutions such as electric lighting and mechanical air conditioning units, without any consideration of alternative solutions appropriate to the climate.

Yet this technology is affecting the health of occupants.

Questions have been asked about the rationale behind the physical and psychological separation of indoor and outdoor and the impacts of this on occupant well-being. If the separation of the indoor air and outdoor air by design is a problem, then it is time to reconnect them by design.[110]

At public hearings the architects Lindsay and Kerry Clare were asked about the relationship between design and SBS.

> **CHAIR**: Do architects design specifically to address such problems as sick building syndrome?
>
> **Mr CLARE**: I do not think an architect designs that specifically but an architect should design in a holistic way with regard to a range of requirements — energy, use of energy, comfort levels, physiological and psychological aspects in terms of health. It is part of an overall approach. It can be separated but there are so many other issues and they are all interconnected issues. There is also their contribution to greenhouse gases, life cycle costing et cetera. All those things are, in a way, interconnected[111].

[110] Building Science Forum of Australia, NSW Division, op. cit. pp16-18.
[111] Transcript of Evidence, p35.

Dr Brown in his submission to the inquiry pointed out that "the design of new buildings to minimise indoor air pollution and SBS effects is the most effective strategy for control".

Sustainable Design Principles

The Committee heard on a number of occasions that the current trend to design in a sustainable way would have positive health outcomes for occupants because a sustainable approach would lessen or even remove the factors which reduce the quality of indoor air and contribute to SBS.

The submission from IEQ Technology asserts that "sustainable design and indoor air quality (IAQ) have not yet been adequately recognised and accepted as important priorities by the building design professional".[112]

In this regard the question of government policy was put to the Clares at hearings:

> **Mr HICKEY:** From the New South Wales Government's perspective, what broad policy changes could be made to address the quality of indoor occupation?
>
> **Ms CLARE:** As I said before, probably the sustainability issue as an encompassing umbrella because that will filter to many things such as energy use, life cycle costing, greenhouse gas emissions and sick building syndrome. It does a lot of things, but there is a long way to go as far as educating the occupants of a building and how to use a building, educating the population in general towards such issues as sick building syndrome, but also educating architects to allow more time for them to absorb those issues.[113]

Lindsay Clare advised that as well as education it was a matter of engaging the appropriate design expertise:

> **Mr CLARE:** A lot of those issues were things that were done 100 years ago by rule of thumb and people through tried and proven methods knew there were certain things you could do. Now technology is available to test those systems. So, you can have more natural systems in place and test them in regard to daylight, air quality and air movement through a computer system. We often employ an environmental consultant to assist. It is a matter of developing that rather than having the standard system of employing a mechanical engineer to sort of pump things into it. I am not sure if that has answered your question on policy.
>
> It would be important for people to have to explain why they could not design a building in that way. We are not talking about high-rise buildings. We are talking mostly about public low-rise buildings, some in urban areas and some in rural areas. The majority of those buildings could be designed with mostly passive systems to which technologies could be added when required. There would be circumstances when that could not be met. That should almost be explained to a committee. There could be a review committee which asks, "Why haven't you done that?" You have to demonstrate why you would have to have the technology fixed to the building rather than the reverse.[114]

According to the Clares, the implementation of sustainable design in building procurement will lead to improved indoor air quality. However, while some agencies were adopting these policies, for others the apparent "bottom line" ruled:

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[112] IEQ Technology, Submission to the Inquiry, No 4
[113] Transcript of Evidence, p37
[114] ibid, pp37-38

> **Ms CLARE:** We have found that there are deficiencies in that some departments commissioning or purchasing a building do not have the parameters in front of them of what is important. We consider that if there were some policy within which they had to consider sustainability when procuring buildings, that would be an umbrella that would filter down to address issues such as sick building syndrome. Some departments have a very strong policy towards that. For instance, TAFE generally had an extra funding stream for environmental issues to get environmental consultants and things like that. That was very good. Schools have a strong policy with daylight and materials, toxins and things like that. I cannot say that we have come directly in contact with anyone that was totally against those issues; it is just that they might have been told that budget was more important in procuring a building.[115]

This "bottom line" approach is short-sighted as a long term view which considers life cycle costs presents another picture. As IEQ Technology advised in its submission, "the concept of 'life cycle assessment (LCA) of building materials and products requires the inclusion of IAQ to achieve improvement in the overall performance of buildings".[116]

This view was supported by DPWS at the public hearing:

> **Mr SMITHIES:** Chris is talking in terms of ESD more generally, but if you were bringing it back down to things like the sort of space we are occupying and the air we are breathing in a place, you can apply ESD principles at that level as well. That comes into things like the whole-of-life costs. Chris was talking in terms of timber on the wall. It might cost you a bit more to put timber on the wall initially than to put some kind of epoxy-based finish on the wall. That is the sort of stuff we are talking about: have a bit of a longer perspective, rather than just a cheaper up-front finish. For example, you can design a cheap and nasty air conditioning system that costs you an absolute bomb to run, low-capital costs, but you are doing yourself a disfavour in the longer term. The same sort of principles apply with sick building syndrome. You take a longer perspective and look at how it impacts on the people who will live in the building. If your ESD principles are embodied in that philosophy, I think you are a long way down the track of making sure that sick building syndrome does not occur.

And elsewhere by Mr Smithies:

> **Mr SMITHIES:** ….. If I was to sum up, I would say that as much as possible we try to embed or embody ecologically sustainable development principles in the design, acquisition and management of facilities.[117]

The Clares had a similar view:

> **Mr HICKEY:** The scary part of that [sustainable design] may be cost.
>
> **Mr CLARE:** In relation to the building?
>
> **Mr HICKEY:** Yes, in relation to the building.
>
> **Ms CLARE:** In our experience there is always more initial cost when you have things like sun shading. They are all add-ons, as Lindsay said, that you can strip off. If you had a black

[115] ibid, p37.
[116] IEQ Technology, Submission to the Inquiry, No 4
[117] Transcript of Evidence, pp39, 47.

> cube, it is much cheaper to build, but it is the long-term costs that we usually convince our clients about. We can prove the energy reduction and the cost of productivity and sickness.
>
> **CHAIR:** Loss of productivity is rarely taken into account.
>
> **Mr CLARE:** Any end user client should be concerned with cost over a longer period rather than the short term.[118]

Environmental design in construction of new schools

The construction of new schools is an excellent example of how design can incorporate principles of sustainability and a healthy indoor environment. DPWS has been developing sustainable strategies in school design using environmental and indoor air quality principles which emphasise natural ventilation, natural lighting and low-VOC products.

These developments are particularly important given the susceptibility of children. As Ms Immig pointed out, it is easy to overlook the amount of time children spend indoors at school. They spend many years in that environment, and are deserving of the same attention given to workers in their workplaces.

These school designs provide examples of strategies that could be used for improving other government buildings and which might feed into larger office design.

At the public hearing, the Committee questioned DPWS officials on this issue:

> **CHAIR**: Indoor air quality in schools is very important. Can you run through some of the examples where the department is applying environmentally sustainable design [ESD] principles in the construction of new schools?
>
> **Mr OH:** One of the things that is interesting in the schools, just to start off with, is that the cost per square metre is roughly the same as it costs to build a house in a developer's lot in the suburbs of Sydney. All our primary schools are naturally day lit and naturally ventilated. They have turbo extractor fans which helps to circulate air through the building. They have single loaded corridors, low odour paints and an acoustic rating in specialist areas. For example, a quiet room off the side of a classroom for kids to have a conference has a special acoustic rating so it does not disturb the children in other classrooms. They have low odour paints and long, deep verandahs so that you exclude the sun and glare in the classroom. One other thing which we are constantly on top of is that we go back to the school after it has been built and occupied and talk to the people who use the building and see what they think about it. We then feed that back into school designs.
>
> This is done by a specialist education facilities research group which is staffed by the Department of Public Works and Services [DPWS] and Education. Some of the things we have learnt in primary schools, we are taking into high schools. One feature of Camden High School, which we are building at the moment, is that it will have natural ventilation and natural day lighting in a lot of the classrooms, which I believe is a first for high schools in Australia, or even in the world. We are constantly working on getting sustainable design features into schools at all times.

[118] Ibid, p38.

> **CHAIR**: Yes. A lot of emphasis is placed on making those buildings comfortable with natural ventilation and proper lighting.
>
> **Mr SMITHIES**: I think the joint exercise between DPWS and Education in terms of school design and how it has evolved has probably been going on for 20 years now. That is one of the biggest successes when you look at the cost of provision of the school facility and when you think about a facility that clearly needs to be more robust than your average domestic construction. When you are delivering that facility at a comparable cost, you are seeing environmental outcomes in the design. I imagine that each time you have been to a school you have seen that the next generation has evolved a little better. The strength is having the two groups together: the people who are delivering the education service within that environment, and the people who are designing the environment around it.[119]

The Committee provides three school case studies.

Nemingha Public School
In the early 1990s DPWS in conjunction with the then Department of School Education developed an innovative, environmentally sustainable design for a public school at Nemingha near Tamworth.

The site for the school was in a major drought prone area that was not linked to the town water supply. The design developed by DPWS included developing innovative ways to capture rain and stormwater to use on the site. The building was constructed to conserve energy through the use of materials, insulation and finishes which were assessed for thermal performance. The school's landscaping was also designed to harness the prevailing winds to cool in summer, and planting allows sunlight to penetrate in winter while protecting the buildings from direct sunlight in summer.

Nemingha Public School won the prestigious Environment Award at the 1995 NSW Architecture Awards.

Buxton Primary School
In October 1995, DPWS was commissioned to design a new primary school for Buxton. This design was to incorporate the latest environmental techniques used in the development of Nemingha and to take a proactive approach to IAQ issues.

Environmental techniques similar to those used at Nemingha such as landscaping to shelter the buildings and passive solar design to maximise light, were included at Buxton. The design also included roof ventilators to improve ventilation and air movement within classrooms. The design and construction of the school concentrated on using materials that had minimal environmental impact and contained low or nil VOCs (e.g., environmentally friendly paint) in an effort to reduce emissions that could potentially affect SBS.

Many of the features included in the Buxton project have now become standard in the construction of new schools.

Camden High School
According to DPWS, the school "is a benchmark passive building, complemented with low energy mechanical systems, providing the best possible energy performance in the context of life cycle costing, low energy and carbon dioxide savings to the environment, and supports a healthy building environment." (S11)

[119] Ibid, pp45-46

SBS related features of Camden High School include:

- Passive natural ventilation utilising solar chimneys and thermal buoyancy to ventilate the deep plan buildings.
- Use of thermal mass to provide summer comfort conditions with night flushing to remove daily heat build up.
- Sunscreening of all windows and management of east west exposure.
- Incorporation of natural daylight with shaded roof lights where possible.

Other examples
The government building stock tends to be medium to low rise buildings for which many of the design solutions outlined in this report are readily suited and through DPWS are being implemented. While there is a perception that it is more difficult to apply these approaches to high rise buildings, the Committee has also been made aware of innovations in high rise buildings overseas. For example:

- The incorporation of a number of specific design features in the Bankers Trust office accommodation in the Chifley building resulted in a noticeable improvement in the office workers environment with benefits including:
  - 10-29% reduction in cleaning costs
  - reduction in employee lost time due to illness (approx 10%)
  - reduction in dealer fatigue[120]

- Germany's Commerzbank set radical conditions in the competition for its headquarters tower in Frankfurt, Germany. For instance, the building was to use ambient energy as much as possible to reduce the amount of fossil-fuel derived power; users were to be exposed to the beneficial effects of contacts with plants; and individuals were to have the possibility of opening their own windows to be able to obtain fresh air, even on the highest floors.
- the 1987 Internationale Nederlanden (ING) Bank headquarters in Amsterdam uses only 10 per cent of the energy of its predecessor and has cut worker absenteeism by 15 per cent. The combined savings run to more than $6 million a year. Significantly, this project brought together engineers, architects, scientists and future occupants to consider numerous concerns simultaneously, and achieved a result no one group could have in isolation. That sort of cooperative approach is what is required to forge a change toward more sustainable buildings.
- The Thai government has commissioned a 25-storey office building that will use 80 per cent less energy than others in Bangkok.

From a sustainable design perspective, mention should also be made of the following:

- In the US, the country's largest architectural and engineering firm is evaluating the environmental and health impacts of all the materials that it specifies.
- Most major German cities have shops that sell healthy building materials.

[120] Building Science Forum of Australia, NSW Division, op. cit. p25.

- Sweden's largest housing bank announced in early 1995 that it would lend money only for ecological buildings.

IAQ in the home
While the Committee has concentrated on IAQ in office settings, it is well aware that IAQ problems can also occur in the home.

A recent CSIRO study has found that 500,000 Australians are living in homes containing air with a toxicity 20 times above the national limits set by the NHRMC. Some took 10 weeks to fall below the recommended levels.

For the same sorts of reasons that new offices are more prone to make people ill — new building products, carpets, paints and furniture give off more fumes — new homes pose a greater risk to health than old homes.

Procurement policy
The capital works and goods and services procurement system in the New South Wales public sector totals some $10 billion per year. It is overseen by the DPWS, which sets the policy framework and standards for all government agencies as well as acting as a service provider for individual government agency clients.

The DPWS, therefore, has the central role in facilitating reform and developing — and then maintaining — an effective government procurement system. To this end, it works in close collaboration with peak procurement bodies such as the State Contracts Control Board (for goods and services) and the Construction Policy Steering Committee (for capital works).

It also acts as the New South Wales representative at a national level through membership of the Australian Procurement and Construction Council, which seeks to develop consistent national standards. New South Wales has played a leading role in this body in recent years, promoting the extension of its own reforms to other jurisdictions.

In its annual report, the department identifies its strategies in carrying out its whole of government function (objective 2).These strategies include:

> *2.2 provide leadership in the development of the building and construction industry, and*
> *2.3 use the Government's purchasing power to in government construction and procurement to ensure industry progress towards ecologically sustainable development*[121]

Comment
IAQ is not a major factor in new building design. Regrettably, the needs of the occupants in the office environment are always and afterthought, if they are considered at all.

While improving HVAC technologies and introducing more environmentally friendly fit out materials (discussed below) are likely to reduce the negative impacts of indoor air pollutants on human health, this is probably not addressing the problem at its root cause. The contemporary problem of indoor air quality appears to have emerged when indoor air was created by separating it by technology from the outdoor air.

[121] Department of Public Works and Services Annual Report, 1999-2000, p18

A more long term solution will be found with a comprehensive adoption of ESD principles in building design, which will tend to reduce this artificial separation of the indoor and outdoor air.

Design is obviously the key to improving the quality of indoor and related health problems in new buildings.

There are a number of examples, both in the public and private sector, which show that the knowledge and expertise is available to construct buildings which have good indoor air quality.

These buildings are generally designed on ESD principles.

Indoor air quality, therefore, needs to be included as a key design input as part of a broader focus on the principle of sustainability in design, which also feeds into other key issues such as energy use, greenhouse gas emissions, and life cycle costing.

The lessons of the excellent work of the Departments of Public Works and Services and Education and Training with schools in NSW need to be applied across the public sector.

Environmental problems such as SBS are by their very nature relational. The problem of SBS should be seen as part of a broader environmental problem where indoor air pollution is not separate from outdoor air pollution and neither can be treated in isolation of the question of sustainability.

The Committee believes that the public sector should take a lead in raising awareness about IAQ issues. By adopting practical measures to foster growth in the application of ESD principles in building construction and accommodation management, and the widespread use of low emission building products and furnishings, the Government can pave the way for a better indoor air environment for occupants of all buildings.

The leverage which goes with being a major player in the market gives the Government the opportunity to influence the way that not only the public sector but also the private sector operates.

The best way to deal with indoor air quality problems is to design out potential causal factors.

The Committee therefore is of the view that more emphasis should be placed on IAQ issues in public sector procurement procedures, in relation to both capital works and goods and services.

DPWS is ideally located and focused to play a significant role in furthering these issues. In fact, the department would be building on whole of government policy which it is currently undertaking.

Government procurement is a powerful tool. Improved indoor air quality and the prevention of associated illnesses such as SBS should be a factor in procurement policy.

These design approaches can be progressed in a number of ways.

Firstly, these key design inputs need to be formally included in the Building the Code of Australia.

Secondly, the Committee believes that the Government can lead the way in encouraging sustainable design (which will include measures to ensure IAQ) of new buildings. This approach has two elements:

1. **The Government can ensure that the principles are implemented in all buildings for which it has responsibility.**

   DPWS, in collaboration with agencies such as Education and Training, are already well advanced in this area. The Committee appreciates that changes have already been made in these areas under the Department's leadership. What is needed is to ensure the lessons are implemented across the board by means of a whole of government policy.

   For the most part, the Government builds low rise buildings such as hospitals and schools. Likewise, the vast majority of office blocks built by the Government are low rise buildings. In that light, the Committee can see no reason why a government agency should not be required to give preference to tenderers who can supply a building constructed on the principles of sustainability, including extensive use of natural ventilation and daylighting.

2. **The Government can use its role as a major player in the construction industry in New South Wales to influence the construction and building industry to implement these principles in the private sector, in both commercial and residential buildings.**

   The Department of Public Works and Services as the government's expert on construction matters is best placed to lead these developments both in the public and the private sectors.

Such approaches should put considerable emphasis on life cycle costings so that the cost of poor design is reflected in the analysis for design options.

As Mr Clare so succinctly expressed it: Any end user client should be concerned with cost over a longer period rather than the short term.

Poor decision making such as that identified at the Overseas Terminal need to be prevented.

The case study highlights the point the Clares made about the dependence on a narrow expertise at the design stage. The Committee was swayed by the arguments to better inject environmental expertise into the design process by means of utilising environmental design experts and the establishment of a review panel to adjudicate on environmental design.

There is no unique solution and all buildings need to be considered on a case by case basis. It should be borne in mind that solutions will always need to be tailored to specific buildings or locations within buildings.

The Committee sees such a review committee as utilising a system similar to the National Home Energy Rating Scheme (NatHERS) operating in many local government areas throughout Australia. The NatHERS scheme is based on the accrual of points for compliance with energy saving components such as ceiling insulation, correctly oriented windows, shading by eaves and a high-efficiency hot water system. Could be a template for IAQ

RECOMMENDATION THREE

THAT the Building Code of Australia include specific measures to ensure IAQ which promotes occupant well-being.

RECOMMENDATION FOUR

THAT Government agencies utilise the expertise of environmental architects and designers in the design phase of buildings in order to minimise possible IAQ problems by looking at the full range of design options.

RECOMMENDATION FIVE

THAT as part of the implementation of ESD principles the Government establish a review committee to vet proposals for significant capital works projects with respect to design elements to ensure high quality IAQ.

RECOMMENDATION SIX

THAT the optimisation of IAQ be part of the tendering process for relevant capital works projects as part of the implementation of ESD and life-cycle costing principles. New buildings should have clearer documentation and guidelines relating to SBS prevention.

RECOMMENDATION SEVEN

THAT an SBS best practice guide for designers be produced.

RECOMMENDATION EIGHT

THAT SBS practice codes be developed for building construction.

RECOMMENDATION NINE

THAT the IASC consider ways to implement the DPWS/ Education and Training model of ESD more broadly across the public sector.

The Committee now looks at three specific issues related to the design and construction of new buildings. These are:

- Heating, ventilation and air-conditioning systems
- Removing pollutant sources
- Commissioning.

4.5.2 Heating, Ventilation and Air Conditioning Systems

The growing reliance on mechanical HVAC systems to maintain indoor environments has led to an increasing number of IAQ problems. This practice highlights the (perhaps unhealthy) desire to separate the inside environment from the outside.

One well known and potentially fatal example of a health problem associated with evaporative water systems is legionnaire's disease.

As the "lungs" of the building, HVAC systems critically influence so many of the essential characteristics of the quality of internal air, such as temperature, humidity, cleanliness and air movement. They can:

- be the primary source of air contaminants
- transfer contaminants from their source to people in the building
- fail to remove contaminants from their source.

Air conditioners in Australia work on the principle of recirculating internal air and introducing only small amounts of outside air. The low amounts of introduced outside air are mainly aimed at reducing energy costs because outside air requires more energy to bring it to the desired temperature. This, however, can lead to a build up of pollutants.

However, the solution is not always simply a matter of increasing the ventilation, as Mr Brown explained in hearings: "You may be able to double the ventilation but if you have a strong pollution source that may be emitted 100 times higher than is wanted, you will not achieve much by doubling the ventilation."

A survey carried out by Healthy Buildings International between 1980 and 1988 identified the most significant indoor air pollutants (see chart below). They found that "the two major sources, allergenic fungi and dust particles, can be directly related to ineffective ventilation systems". [122]
As pointed in chapter three, a number of researchers have noted SBS is more common in mechanically ventilated buildings than naturally ventilated buildings with openable windows and backup cooling and heating devices.

Thus natural ventilation not only has the advantage of reducing energy costs, it is likely to reduce SBS.

Features which should be considered in the design of HVAC systems to ensure high IAQ include:

- Location of air intake duct position away from pollution sources (cars etc.)
- Use highly efficient air filters, where appropriate
- Good air movement
- Proper zoning of air conditioned areas
- Provide adequate and safe access for maintaining and servicing equipment. (For instance, have dedicated rooms for air conditioning equipment instead of placing it in ceiling spaces)

[122] Building Science Forum of Australia, NSW Division, op. cit. p14.

- Avoid places where moisture can accumulate to enable colonisation by microbiological organisms
- Use ducted vacuum cleaners
- 'Flushing' of buildings overnight
- Ensure appropriate positioning of vents etc. when partitioning office space.
- Allow occupants to control ventilation, thermostats and lighting by means of a simple system which can react quickly to changed requirements.
- Avoid dead spots and draughts in air distribution.
- Locate thermostats where they will not be affected by local heat gains (eg from photocopiers), solar radiation or air streams from diffusers.

4.5.2.1 Natural and hybrid ventilation

There are two major alternatives to full mechanical ventilation:

- *Natural ventilation* utilises openable windows and/or other passive ventilation techniques.
- *Hybrid ventilation* is the strategic combination of natural and mechanical ventilation.

The moderate climate of much of NSW is well suited for the use of natural and hybrid ventilation with supplementary heating and cooling as required, thus avoiding an instinctive recourse to mechanical ventilation. In her presentation to the Building Science Forum of Australia, Willis states:

> *There is a vast difference between mechanical services that enhance the efficiency of well designed buildings versus mechanical services substituting for the inefficiency of poorly designed buildings. Providing there are not problems with external air quality, it is possible with good architecture and the use of natural ventilation to reduce the use of air conditioning by at least 50 per cent. This would have the dual environmental benefits of reduced greenhouse gas emissions and indoor environments that are healthier for their human occupants.*[123]

There is a growing number of examples of innovative hybrid and naturally ventilated new buildings such as schools, houses and offices.

At last year's National Architecture Awards, the Royal Institute of Architects noted in awarding the Ecologically Sustainable Development Award and the Energy Efficient Design Award to the NSW Institute of Languages that the design encompassed "the benefits of natural ventilation, natural lighting and an efficient system of supplementary air conditioning with invention and intelligence." Its "summer strategies include automatic night cool air flushing of the modules and brown-out blinds; winter strategies include insulation, solar energy, and larger glazing frames providing the insulation of thicker glazing."

The concept of natural ventilation is usually not as straightforward as simply providing openable windows, particularly in large offices. Architects work with specialised engineers to develop

[123] Ibid, p17.

strategies such as designing air flows using atria that create a stack effect, ventilation shafts, computer assisted window openers (in high rise buildings) and so on. This method of design requires an integrated approach and therefore architect and consultant fees are usually higher. However, such fees are very small in comparison to construction costs, maintenance costs and staff costs.

New HVAC technologies such as hybrid air conditioning are moving towards reducing SBS and achieving more sustainable design. Australian companies are making new advances in HVAC systems such as 100 per cent fresh air systems that introduce fresh air and expel internal air thereby removing the build up of internal contaminants. New advances in HVAC technologies should be encouraged, with the careful condition of their merits on a case by case basis. Energy consumption of these technologies is also an important factor to consider.[124]

High quality air filters are also claimed to provide solutions to acute indoor air pollutants. The Committee inquired about such systems during the hearings and received the following advice.

> **CHAIR:** You mentioned particle filters. Are they expensive things to re-fit into a building?
>
> **Mr BROWN:** They can be if the mechanical ventilation system cannot deal with the pressure drop they create. Particle filters have a certain amount of pressure drop across them. As they load up with particles the pressure drop will increase, and at a certain stage they have to replace them or clean them. The high-efficiency filters tend to have a high pressure drop from the word go and you may not be able to pump sufficient air through to operate the mechanical ventilation system. So I am not sure whether there are products that are low pressure, high-efficiency particle filters commonly available now. You would have to ask a ventilation engineer that question. I can tell you that I am seeing some products from overseas that are designed to be low pressure drop filters based on other processes, where they use electrostatic or electronic operation to cause a charge that charges the particle that attaches to a surface. We are assessing those for some of those companies. So a new wave of filters may appear in the marketplace that will be able to be used. I suspect that these products are coming in because there are no low pressure filters around.[125]

The Committee also received information on commercial ionizer technology which are claimed to improve the indoor air quality by restoring the ion balance in the indoor environment. (See Appendix F)

As the Committee has already noted, natural ventilation equates with a lower incidence of SBS. More research in this area is needed to determine exactly why naturally ventilated and hybrid buildings often perform better, but some reasons why this is the case could be:

- The increased amount of outside air displacing polluted indoor air in a naturally ventilated building (assuming levels of outside pollution are not too high).
- The increased control occupants have over their immediate environment and the ability to adjust temperature according to personal preference.
- There may also be the perception of connection with the outside environment which may increase the feeling of well being. This is obviously dependent on the location of the building and outdoor sources of pollution.

[124] Associate Professor Prassad, Director of SOLARCH, UNSW, Submission to the Inquiry, No 3
[125] Transcript of Evidence, p10.

- Openable windows can provide the varied sensory experience that one experiences outside.

4.5.2.2 Individual occupant control

Most office air conditioning is centrally controlled. This means that individuals lack control over their own environment, a potential source of frustration for workers. The perception of one's environment and the ability to influence it has a powerful effect on feelings of comfort, health and well being. For example, fixed windows also reduce occupier control.

A single set of environmental conditions will not suit everyone and low individual control is associated with annoyance, stress, higher prevalence of SBS symptoms and low productivity.[126].

Professor Derek Clements-Croome of Reading University has recently stated:

> *As human beings, we have a deep desire to control our environment. If the windows are locked because of the air conditioning, that will create resentment and depression among workers.*[127]

This is particularly relevant to SBS, where psychosocial responses are defining features of the problem.

Some researchers have reported that satisfaction of occupants with the indoor environment is much improved when they have access to controls that can be used to change conditions and achieve rapid feedback when they need to do so to correct an unsatisfactory condition.[128]
The Committee inspected the Wilkinson Building at Sydney University at the invitation of Mr David Rowe, of the University's Department of Architectural and Design Science.

The Wilkinson Building operates on an energy efficient hybrid ventilation system. Rooms are equipped with openable windows and refrigerated fancoil units capable of cooling or reverse cycle heating. Individual climate controls allow occupants to adjust thermostat points as they wish. Workers therefore have the option of using either mechanical or natural ventilation, or a combination of both. This gives occupants a degree of flexibility in controlling the environment in which they work. In other words, not every worker has to put up with the climate dictated by a centrally controlled, mechanical air conditioning system.

The Committee understands that this system has led to a very high level of satisfaction with the indoor air environment in the Wilkinson building.

Similarly, Mr Rowe's data shows that buildings with openable windows and user-controlled supplementary cooling and heating facilities have low SBS symptom prevalence together with considerably better scores for thermal air quality.

Rowe's results are supported by a study from McGill University in Canada.[129]

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[126] Raw G, Sick Building Syndrome: A review of the Evidence on Causes and Solutions, Health and Safety Executive Contract Research Report No 42/1992, UK Garston, Watford. HSE.
[127] Sydney Morning Herald, 1.10.00.
[128] Bordass W, Bromley K, Leaman A, (1994), User and Occupant Controls in Office Buildings, in Sterling E Bieva C and Collett C (eds) Proceedings of International Conference on Building Design Technology and Occupant Well-Being in Temperate Climates, Brussels, February 1993.
[129] Building Science Forum of Australia, NSW Division, op. cit. p36.

Comment
While an insufficient supply of fresh air can contribute to SBS problems, it is naive to imagine that simply turning up the controls on HVAC systems will eradicate SBS. Reducing energy consumption is still a worthy — in fact, it is an essential — objective, and the Committee supports the Government's efforts to do so.

HVAC systems should form part of a solution to ensuring a healthy indoor environment not be an end in themselves.

A better approach would be to ensure a more user friendly indoor environment, utilising a fresh air supply and natural light at the design stage of construction.. This can be married to the introduction of energy efficiency. Such an approach not only makes workers happier, it saves the Government money it might otherwise have to find to rehabilitate a building at a later stage, when problems arise.

The Committee feels that other emerging technologies, which might be useful tools in dealing with indoor air quality should receive consideration on a case by case basis.

However, the Committee also feels that this approach is dealing with the symptoms, and not the causes, of systemic problem. The best use of these systems, then, would be in retrofitting existing buildings rather than a longer term solution to indoor air quality problems.

There are a range of options which can be incorporated in new building design to provide a ventilation system which will ensure good qualit0y indoor air, which in turn will reduce health problems such as SBS. These might appear more costly at the outset, but any up front cost will be recovered through the life of the building.

RECOMMENDATION TEN

THAT new buildings be designed to:

- **Minimise heating and cooling demands of ventilation**
- **Minimise the introduction of polluted ventilation air**
- **Minimise energy demands of supplying and removing air**

RECOMMENDATION ELEVEN

THAT the use of new HVAC technologies, such as hybrid air conditioning, 100% fresh air systems and high quality air filters be considered on a case by case basis as part of the design of new buildings or as part of major renovations.

RECOMMENDATION TWELVE

THAT the design of HVAC systems should, where feasible, provide occupants with individual control over their workspaces.

RECOMMENDATION THIRTEEN

THAT, where possible HVAC systems should be designed with the final use and layout of the building in mind. Where this is not possible, building internal layouts should not conflict with existing HVAC systems.

RECOMMENDATION FOURTEEN

THAT AS 1668.2 include provisions to specifically improve IAQ, particularly SBS.

4.5.3 Limiting Material Sources of Pollutants

There are three types of indoor air pollutants – chemical, biological and physical. They are found in a range of building and finishing materials, appliances and the activities of occupants.

The opportunity to guard against poor IAQ in a building, therefore, lies not only in its design, but in its fitout and choice of materials.

As discussed in chapter two, new buildings have particularly high levels of pollutants such as volatile organic chemicals released from outgassing of the new building materials and furnishings such as timber products, adhesives, interior finishes, paints, furniture and wet glue. These gases are released at higher rates initially which then diminish over time. Some materials, including soft furnishings and some porous finishes, act as chemical sinks that absorb the chemicals and re-release them over an extended period.

There are no nationally legislated indoor air quality standards for concentrations of pollutants in indoor air that apply to the general public.[130]

Except for those developed for formaldehyde, Mr Stephen Brown told the Committee there were no standards for building product emissions, although some industry groups had an interest in driving down emissions:

> **Mr BROWN:** … One is the wood-based panels industry which has been reducing the formaldehyde emission from particle board, fibreboard and plywood for probably 10 years. They now claim that the industry is meeting a low emission target that the European industry uses but the way the industry has verified that is not by the same method as is used by the Europeans. ….. but the industry is certainly trying to drive emissions down to a lower level and attaining the level is only a matter of deciding what is the appropriate level and what is the appropriate method by which we measure that level.
>
> The other example is unflued gas heaters. The unflued gas heater industry has been reducing the emissions of nitrogen dioxide from those heaters over the past 10 years as well. Those heaters have been shown, in some health studies of schoolchildren, to be affecting respiratory health of children, perhaps asthmatics and so forth. The industry has been reducing the emissions but the question is whether it has reduced them to an adequate degree. …
>
> In summary, some industries have an interest in reducing those emissions because they do affect the people using their products, but we do not have a standard method by which we measure those emissions, a common yardstick. Without a common yardstick I do not believe we can have any criteria, because are we talking in apples, bananas or pears. There is a need, and some industry has the will, but we need to move the issue forward. This is to control the pollutant levels in buildings. We are assuming that will also affect people's health, whether it be sick building syndrome or more significant health effects. General respiratory health is not

[130] Ibid p2.

> necessarily sick building syndrome, but I do not know whether it is related. It is a very hard question to answer.[131]

Critically there is a shortage of useable information to help decision makers.

Two witnesses, the CSIRO's Stephen Brown and the Total Environment Centre's Jo Immig, co-authored *Indoor Air Quality Guidelines for Sydney Olympic Facilities*, which included a set of environmental guidelines to select building materials.

Ms Immig's evidence drew the Committee's attention to the difficulty in accessing information which architects and designers could use to source low-emission building materials and furnishings:

> **Mr GIBSON:** What are the main features of the Olympic air quality guidelines? Are those features different from the normal guidelines for most other buildings?
>
> **Ms IMMIG:** It was an interesting process having to do that work in relation to the Olympics. I am sure you are aware that part of the environmental guidelines included a guideline to select building materials with low emission rates. Contractors came to the Olympic sites and said, "Where are these materials with low emission rates?". As Steve [Brown] said, we do not have databases that a designer or an architect can plug into and say, 'Yes, this brand of chipboard has less formaldehyde than that brand.' If you are an architect that task is incredibly difficult. I was commissioned by Green Games Watch 2000 at least to provide some guidelines that may help some of these people who contacted us at the time and said, 'We have been given this guideline and we must do something; please help us out. How do we choose these materials?'.
>
> We set about trying to write those guidelines in as practical a way as possible and to help those decision-makers make those decisions. I think it was the first time that we had pulled together a lot of the technical literature and tried to provide a decision-making framework. We looked at sources that were beyond just engineering solutions like air conditioning or end of the pipe solutions. We were looking at design options and providing a framework for material choice selection. They are the main features of the guidelines that differ from other material on indoor air quality. Because there is such a lack of standards and guidelines regarding indoor air pollutants we tried to address that as well but it was an incredibly difficult task and we had a very short time to do it in.[132]

The NHMRC interim goals for IAQ address indoor air pollution by expressing its upper limit concentrations for various indicator air pollutants, including carbon monoxide, formaldehyde, lead and ozone. Only nine indicator pollutants have been defined at this stage, which does not represent the full spectrum of pollutants and factors that can influence IAQ. The boundary between goals for indoor air and occupational exposure standards has become blurred in buildings that act as one person's workplace and another's public place, for example shopping malls. [133]

However, while they provide a guide, caution is required with threshold values. While they offer simple administrative solutions they might not be suitable for individuals within the population.[134]

[131] Transcript of Evidence, pp4,5
[132] ibid p13
[133] S Brown, Submission to the Inquiry, No 7.
[134] Department of Health and Aged Care, op cit. p25.

The Department of Public Works and Services has considerable experience in this area. According to the Department it ensures that, "Government contracts for interior fitout products specify materials that emit low levels of odours." Witnesses from the Department pointed out that the Department was "quite particular" about the carpets and furnishings it chose. They said natural fibres, for which Australians had a liking, caused fewer problems with respect to outgassing from VOCs.

The Department used only water based paints and water based glues wherever possible. To some extent it could specify the use of materials such as VOC-free paints, but could not prescribe materials for client agencies:

> **Mr SMITHIES:** … At the end of the day we respond to the client's brief and we cannot absolutely say to the client, 'This product is good for you, you must have it.' Once upon a time the old Public Works Department operated a little bit like that — some might say a lot more like that — and got up the nose of a lot of client agencies. So, to the maximum extent we can we embody those [ESD] principles, and we have a process where we environmentally review designs and material selection and those sorts of things, wherever possible, to make sure that the client agencies have the best advice.[135]

Other witnesses praised DPWS policy on fit out materials:

> **CHAIR:** The Committee heard evidence about emissions from paint, carpet and furniture. Do you consider those aspects in your buildings?
>
> **Ms CLARE:** Yes. The Department of Public Works and Services as design directors has in place very good policies with regard to what fabrics, carpets, finishes and paints to use in schools in particular. TAFE colleges have the same and I am pretty sure hospitals have similar checklists. They are reasonably easy issues to quantify as far as these sorts of emissions.[136]

According to Mr Brown, the reduction in the use of formaldehyde has not come at increased cost to the consumer.

> **Mr BROWN:** It is very hard to say. The reductions that have been made in formaldehyde in wood-based panels have not added any extra cost to the product. They have been made in a staged, step-wise pattern over the past 10 years by the manufacturers saying to their suppliers of resins, "Reduce the formaldehyde level in the product." That has been incremental. The zero VOC paint that is on the market is about 10 per cent or 20 per cent more expensive than other paints but it is produced at such low quantities I would be surprised if economy of scale could not wipe that away. So, there does not need to be a cost surcharge on it. It is only a matter of being able to select the right materials once you have them available.
>
> Some European countries have their standard methods of measuring pollutant emissions. They have their criteria and they have a database of how products perform. So architects and building specifiers can go into the database and pick what products they want. Everything is documented. Denmark and Finland have more than 300 products in each of their databases. As I said, the architects, building specifiers and designers can utilise that.[137]

[135] Transcript of Evidence, p42
[136] ibid, p 36.
[137] Ibid p5.

Gas heater replacement program
Unflued gas heaters are a significant source of indoor air pollution by nitrogen dioxide (NO_x). Investigations of NO_x levels in NSW schools found that the major factors were gas leaks in the heaters (causing greater nitrogen dioxide production) and room ventilation levels. In some room trials, creating cross-ventilation by opening windows and doors reduced NO_x concentrations, but the practicality of such an approach under winter conditions was questionable.

In 1990 the Department of School Education (NSW) instituted a major program of gas leak rectification in all schools and introduction of low-NO_x heaters.

This program in NSW schools is ongoing and all heaters found to cause nitrogen dioxide concentrations above 300 ppb and heaters in colder areas of the State have been replaced with low-NO_x heaters.

The intention is to eventually replace all unflued gas convection heaters.[138]

Comment
The removal or reduction of pollutants is critical to addressing SBS. In this case, sound IAQ practices need not be limited to new buildings, as many of these products are used in the refurbishment of existing buildings.

It is essential to develop strategies to achieve this goal. The Department of Public Works and Services has considerable experience and expertise in this area which should be utilised.

While the voluntary adoption by industry of approaches to reduce indoor pollutants is the favoured option, it will be necessary to establish some targets.

The NHMRC interim goals for indoor pollutants is recommended as a starting point.

For a longer-term solution it is imperative that that those responsible for the internal design and construction have comprehensive information and incentives to utilise non-pollutant materials. The European database provides one model.

The "Indoor Air Quality Guidelines for Sydney Olympic Facilities" is a useful guide on pollutants which could be adapted for general use in the construction industry.

The Committee makes the following recommendations which will assist in minimising the use of high emission building products and finishes:

RECOMMENDATION FIFTEEN

THAT the interim national IAQ goals recommended by National Health and Medical Research Council be adopted.

RECOMMENDATION SIXTEEN

THAT a database (along the lines developed in Europe) or best practice guide be established containing information on low emission building products, finishes and furnishings for use by architects, designers, developers and clients.

[138] Department of Public Works and Services, Submission to the Inquiry, No 11.

RECOMMENDATION SEVENTEEN

THAT the Government implement a program to phase out the use of products, finishes and furnishings which contain toxic chemicals such as volatile organic compounds. For example, strategies to encourage the use of low emission products, such as preferential treatment as part of tenders and contracts and inclusion in industry codes and standards, could be developed.

RECOMMENDATION EIGHTEEN

THAT the sale of high emission appliances (photocopiers/ printers etc) be discouraged or phased out. Fuel burning appliances should be flued to the outside.

4.5.4 Commissioning

A number of factors relating to indoor pollutant levels and HVAC systems need to be considered upon the completion of a building prior to its occupation.

Indoor pollutants are generally more concentrated immediately after the new buildings have been completed.

For example, in a recent CSIRO study, one office building recorded a VOC reading 20 times the recommended levels the day after its completion.

Another issue with any new building is the proper set-up of any HVAC system.

At present air conditioning system designers are usually not present at the completion of buildings to certify the system is set up to operate as designed. There are no ongoing requirements in regulations to check that the systems continue to perform to design specifications.

Mr Rowe provided the Committee with his views on this at public hearings:

> **Mr ROWE:** A very important point with regard to accepting mechanically ventilated and air-conditioned buildings is the proper commissioning and setting of work. I believe that is often ill-observed these days in the rush for completion. Commissioning and setting work is a fairly time-consuming and painstaking process. The time tends to be used up and people move into the building while technicians are still adjusting and setting things up. People can experience quite a lot of discomfort and I suggest that the disturbance of moving adds to that. They can take a dislike to building, which takes a long while to wear off and I believe colours their impression of its effect on them generally and possibly on their health. Commissioning and testing is essential….
>
> A gentleman called Williams at Melbourne University did a study in 1991 of 53 small suburban offices in the suburb of Footscray. He found that 23 per cent of them had no commissioning records on the site. So how technicians could be expected to adjust them no-one knows. I suggest that would be not untypical of the situation in Sydney. Commissioning tends to be done very poorly and the records are kept very poorly.[139]

[139] Transcript of Evidence, p31

Measures can be taken prior to occupancy to ameliorate these potential HVAC and indoor pollutants problems:

- "Cure" building surfaces and furnishings by "flushing out" (extended period of ventilation). Workers who move into a new or newly refurbished building which has not been sufficiently ventilated may find themselves in a space pungent with fumes, giving poor first impressions of the IAQ which may be difficult to reverse. While "baking out" (heating and ventilating) has been attempted in other countries, witnesses told the Committee the results were unclear at best.
- Careful and correct calibration of the heating, ventilation and air conditioning (HVAC) system, including carrying out complete testing, adjusting and balancing.

Comment
The Committee appreciates that commercial imperatives create pressure to occupy new buildings as soon as they are physically completed.

However, there is considerable evidence that Sick Building Syndrome and other problems associated with poor indoor air quality can be caused by not ensuring that new buildings have been properly prepared for occupation.

The Committee is of the view that time should be spent to properly cure buildings and set up and test HVAC systems.

These are simple but effective steps to help reduce SBS and they should be seen as part of the construction process.

Furthermore, adopting other recommendations in this report, such as removing indoor pollutants materials from buildings, address the causes and not the symptoms. This would eventually remove the need to cure buildings. In this regard, the recommendations cure buildings might well act as a commercial incentive to take more fundamental action on poor indoor air quality.

RECOMMENDATION NINETEEN

THAT new buildings be "cured" before occupation by being "flushed out" (extended period of ventilation).

RECOMMENDATION TWENTY

THAT, where HVAC systems are installed, careful and correct commissioning of the system be carried out to ensure the system performs to the design.

4.6 Management of existing buildings

While it is preferable to eliminate the potential for IAQ problems before they arise (the thrust of section 4.3 above), there is still a need to address problems in existing buildings.

Problems which need to be addressed include poor internal layout, poorly maintained and operating HVAC systems, pollutant levels, inappropriate cleaning and occupiers' activities.

There is certainly evidence of air quality problems in existing buildings, particularly with regard to HVAC systems. Poor ventilation and building cleanliness are important factors in SBS.[140] Williams (1992) investigated the ventilation systems of 228 suburban low-rise office buildings in Melbourne. Occupants of 62 per cent of those buildings experienced unacceptably stuffy, drowsy conditions. An alarming 82 per cent of the buildings failed to meet current ventilation guidelines (largely due to changes in guidelines after the buildings, were constructed).

If air conditioning systems are not operating properly, that is not providing adequate fresh air, air filtration and exhausting of contaminants, they will actually concentrate outdoor and indoor contaminants within the building.

Air conditioners invariably accumulate bacteria and fungi. Research over the last 15 years has shown that air conditioning components such as dust filters and cooling coils are a separate source of airborne microbiological contamination. Fungal and bacterial colonisation is associated with a significant decrease in immune response. [141]

The accumulation of dust and dirt within ventilation components provides an environment for microorganism growth. The cooling coil, drip tray and drain are particularly susceptible. "Stagnant water from humidifiers, condensate pans, cooling units etc can harbour bacteria, fungi, algae, and protozoa". "When dust is deposited on wet surfaces the resulting microorganisms are the source of endotoxins which can be distributed via the HVAC system in the form of an aerosol. As described in chapter two, endotoxins are found in biofilm or bacterial slime. This slime regularly invades wet surfaces inside air conditioning.[142]

Fungi is another important factor in the biocontamination of air-conditioners.

Fungi in ventilation systems can contaminate the indoor environment, causing lung infections, allergic reactions and respiratory irritation. They can be a contributory cause of SBS.[143] A survey of HVAC systems in seven hospitals in the US found a significant proportion of filters to be colonised with fungi, including Aspergillus.[144]

However, it has been argued that the standard annual cleaning and maintenance are not effective in removing biofilm build up. In fact, "even visibly 'healthy' cooling cools and air-handling units show biofilm contamination".[145] Regularly cleaned HVAC units can accumulate significant biofilm between cleaning cycles. Improper use of disinfectants may increase macromolecular organic dust levels due to increasing the level of dead bacteria cells and fragments.[146] These can then be transmitted into the internal air through the HVAC system. Current approaches to cleaning of filters are not effective because "it has been demonstrated that the vast bulk of the microbial colonisation or air filters does not occur on the fibre surface but on the surface of the filtrate (ie the dust particles etc).[147]

[140] Dombrowsky Y and Hill J op cit.
[141] Material supplied by Airway International. For more information see Appendix G.
[142] ibid.
[143] Aerobiological Engineering op cit
[144] Simmons R, Price D, Noble J, , Crow S, Ahearn D, Fungal Colonisation of Air Filters from Hospitals, American Industrial Hygiene Association Journal, 1997.
[145] Dombrowsky Y and Hill J op cit.
[146] Material supplied by Airway International. For more information see Appendix G
[147].ibid.

There are energy efficiency considerations also. biofilm coats the fins and tube in the HVAC system, "dramatically reduces heat transfer". As well, the build up of biofilm on the fins greatly reduces airflow. Both these factors reduces the effectiveness of the systems and increases energy consumption. One commercial organisation asserts that reducing biofilm can increase the efficiency of coils by 5-15% and eliminate the need for coil replacement.[148]

Similarly, fungal build up in filters increases resistance to the air resulting in increased energy consumption.[149]

As one Australian expert has stated, "the elimination of biofilm and fungi from the components [air conditioning coils and dust filters] is paramount to the improvement of human health and efficient equipment operation".[150]

The Committee received material from a one commercial organisation which claims to have products which can be used as part of the HVAC maintenance program to eliminate "biofilm derived bacteria and fungi growing in air handling systems. (See Appendix G)

This approach also, it is claimed, has a major energy savings as air handling and cooling systems consume proportionally large amounts of energy in buildings and the treatment will reduce filter contamination and costs; maximise heat transfer and reduce energy consumption; and extend coil life and reduce coil replacement".[151] The payback for reduced health risk is reduced energy consumption.

Given that dust and allergenic fungi are the most common and significant indoor air pollutants, it essential to ensure the most effective operation of HVAC systems.[152]

There is, however, no requirement for audits or assessments of the potential health risks from indoor air in accommodation either as part of regular maintenance obligations or as part of lease negotiations.

Rather, in New South Wales indoor air quality problems in existing buildings are generally dealt with as Occupational Health and Safety issues.

Tenants can exercise rights through the Occupational Health and Safety Regulations. For example, prospective building occupants can demand an Occupational Health and Safety risk management audit before taking up a building lease. Regular OHS audits may then be insisted upon.[153]

The Committee questioned the officials about what procedures WorkCover had in place to deal with complaints from building occupants about the indoor environment:

> **CHAIR:** If you received complaints about air conditioning and that action [complainant referring the matter to management and the an OH&S committee] was sought and nothing had been done, what sort of action would you recommend management take? The complaint about air conditioning could be a range of things such as being too hot, too cold, too draughty, too

[148] ibid.
[149] ibid.
[150] Broadbent C, quoted in Airway International material.
[151] Airway International Material op cit
[152] Building Science Forum of Australia, NSW Division, op. cit. p16.
[153] NSW WorkCover, Submission to the Inquiry, No8.

still, too stuffy, those nebulous things as opposed to things you would describe as quite threatening, like legionella. What would you advise an office to do?

Ms ST GEORGE: The inspector goes out when he knows there is some level of non-compliance or resistance from the employer or the OH&S committee is not as effective. Looking at the situation and hearing it, in 90 per cent to 100 per cent of cases we will probably leave a notice behind getting them to get an indoor air quality done and we will give them a span of time within which to get that done. They can look up in the Yellow Pages for an occupational hygiene expert to come and do a total risk assessment on the indoor air quality. When they have done that, we go back in and have a look at the recommendation.

We then sit and ask them how they will implement it if it is cost effective because it can be a very cheap one from just maintenance of the air cooling system being required or changing some valves right up to a design fault which requires a substantial cost to put in controls to correct it. Then we will get management to sit down and put forward an action plan on how they will implement controls and what alternatives they will come up with. Then we will inform the OH&S committee and the workers representative, if they have one, on what we have done so the complainant knows what action has been taken and what will be done. And when it is done we come back and then write off the notice. Most of the time they actually listen and do the control measures.

CHAIR: Is the procedure simple most of the time?

Ms ST GEORGE: It is hard to answer. Most of the time it is a mix. Most of the time they manage it quite well, but a small percentage will think of relocating or something like that.[154]

In its submission to the inquiry WorkCover outlined some of the ways in which a building owner can be made to account for the proper design and use of a building:

- Occupants insisting on regular OHS risk management audits of the building ventilation and water-related systems in terms of Sections 45 and 46 of the NSW Public Health Act 1991. This can be implemented through workplace occupational health and safety committees, provisions for which are made in sections 23, 24 and 25 of the Occupational Health and Safety Act 1983.
- Prospective building occupants demanding an OHS risk management audit before taking up a building lease.

Under the draft OHS Regulation 2000 (a new Regulation under the Occupational Health and Safety Act 1983) building owners and managers are required to introduce an appropriate OHS risk management system. This Regulation requires safe systems of occupancy to be in place for tenants of the building under their control.

Experts argued to the Committee that there is considerable merit in having an annual assessment of these systems.

As the CSIRO's Mr Stephen Brown told the Committee at the public hearing:

> **Mr BROWN:** When one thinks about it, a multistorey building could be housing a couple of thousand people and supplying their breathing air. It is probably worth checking on an

[154] Transcripts of Evidence p 19.

> annual basis that the building is still being ventilated at the rate it was intended to be ventilated. It can change. There can be mechanical faults in the system or somebody can change the settings. A very common occurrence is someone moving the partitions around when the building is refurbished, and that changes the effect three offices away, or the next floor up is affected. And no-one knows about it until everybody gets into a state of despair and are feeling sick. One can do a lot with what we already know, by selecting materials and how we operate the buildings to try to improve the air quality in the buildings.[155]

Another issue for consideration is the maintenance of design standards for HVAC systems. Dr Brown advised the Committee in hearings that:

> One can ensure that buildings are ventilated to the standard and that the ventilation standard is maintained over the life of the buildings. As far as I know, there is no requirement to check a building is still ventilated to its designed ventilation right after the building is occupied. It would be negligent legally if one did not. I guess a duty of care probably exists, but I do not see any formal requirement for building owners to have this checked. I believe in New Zealand this is a requirement in some districts.[156]

This point was also made in the Olympic Guidelines, which states that

> *A common problem with HVAC systems is that there is usually no ongoing requirement in regulations to check that the systems continue to perform to design specifications….. The BCA has no requirements of this [the New Zealand] type.*[157]

There are a number of possible reasons for this:

1) Poor maintenance of HVAC systems, or a change of building use that is incompatible with the original HVAC design.

2) Decreased fresh (outside) air intake.

3) The Standard has since been changed and the amount of fresh air raised.

Mr Rowe told the Committee:

> **Mr ROWE:** Maintenance is very important. Buildings with air conditioning need to be kept in good condition. Proper outdoor air supply needs to be maintained. That can get out of adjustment. Temperature control needs careful attention. There is a fairly strong relationship between the perception of thermal comfort and the perception of air quality in buildings. You should use good housekeeping practices, with non-toxic cleaning agents and careful use of pesticides. They are all things that can be done to improve the indoor environment of buildings. Some of them are done carefully by some people, sometimes not.[158]

As both these experts note, as well as ensuring the proper ongoing operation of HVAC systems, it is important to adopt non toxic materials to ensure good cleaning practices.

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[155] Ibid p7
[156] ibid pp6,7
[157] Immig J, Rish S, Brown S, Indoor Air Quality Guidelines for Sydney Olympic Facilities, op cit. p 14.
[158] Transcript of Evidence p31.

New Zealand Model

A number of witnesses and submissions drew the Committee's attention to the New Zealand approach for dealing with HVAC systems.

In New Zealand, the 1992 Building Regulations introduced a requirement for an annual 'compliance schedule' for mechanical ventilation and air-conditioning systems, to ensure these systems are fit for health, as follows:

> *Mechanical ventilation and air conditioning systems shall be inspected regularly to ensure continued effective operation. Inspection content and frequency shall be as follows:*
>
> *Mechanical ventilation and air conditioning systems shall be inspected in accordance with NZS 4302: Part 2 and the designer's recommendations for functional operation and inspection frequency. Where the designer's recommendations are not available, the requirements of NZS 4302: Part 2 shall be meet through compliance with an inspection and maintenance schedule prepared by a person who, on the basis of experience and qualifications, is competent to design heating, ventilating and air conditioning systems.*

There is no such annual 'compliance schedule' for mechanical ventilation and air conditioning systems in the Building Code of Australia.

Case Study

The Department of Public Works And Services provides a useful case study on the management of existing buildings (see submission 11). On behalf of the Government, it manages the Crown Property portfolio (CPP) which is a mix of Government owned and Government leased buildings occupied mainly by Government agencies.

On a three-year rotation, all buildings within the CPP are audited for air and water quality. Any problems identified in the audits are corrected. The DPWS does not do specific SBS audits. Instead, the audits are to establish "general operations efficiency"[159] , however, these audit do investigate areas such as IAQ. As DPWS explained at the hearings, its maintenance programs should resolve SBS issues:

> **Mr FRY:** I suppose we did not actually try to say that we were not addressing the SBS issue. It is just part of our general preventive maintenance in the buildings that would cover any SBS issues that could arise. I suppose that our defence is that we maintain our buildings in good condition. We have maintenance contracts which require regular service of air conditioning systems which would normally involve changing the filters at regular intervals and maintaining the whole system so that it is running at adequate levels. A very important part is ensuring that the building is kept clean.[160]

If major work is required, it is included in the capital works program. Where possible work is carried out during the current year if funds are available, otherwise it is included in the following year's program. "

DPWS conducts internal environment audits in response to building environment problems raised by government agencies.

[159] Department of Public Works and Services, Submission to the Inquiry No 11, p8
[160] Ibid p41.

By way of example of the IAQ problems that can be found in buildings, listed below are IAQ concerns documented by DPWS in one building during one of these audits. The audit was carried out following complaints from the office staff of a government agency about indoor environment conditions. The matters identified were:

- dirty air handling system
- ineffective filters
- low outdoor air quantities
- air movement and distribution
- air damper operation
- recalibration of temperature controllers/thermostats
- balancing of chilled and heating water systems
- provision of air relief grilles
- additional internal shading on windows
- cleaning
- removing air flow barriers (partitions)
- isolating sources of contaminants
- replacing missing ceiling tiles
- monitoring of conditions
- separate air conditioning unit for computer room
- executed drawings and instructions for operation and maintenance of the HVACs including records of control settings established during commissioning should be stored on site for the guidance of maintenance technicians. The system=s design should provide ready access to all components for inspection, maintenance, repair and cleaning.

Strategies to Address Problems in Existing Buildings
Mr Rowe in his submission to the inquiry outlined building diagnosis and remediation procedures, as follows:

> *Should a complaint of sick building Syndrome be lodged by occupants it must be taken seriously and investigated promptly....A stepwise procedure is recommended as follows;*
>
> *Preliminary investigation including discussion with complainants. This may reveal problems of odour, air movement, temperature control that can be fixed easily. The preliminary investigation should examine cleaning procedures and recent changes to the indoor environment. It should enquire whether the effect is local or distributed throughout the premises. Comparison with other premises by way of application of a standardised questionnaire might be useful to compare prevalence of symptoms with a broader community.*
> *Walkthrough inspection with simple measurement of temperature and relative humidity, noting cleanliness, obstructions to air movement, evidence of microbiological colonisation, condition of outdoor intakes and the interior condition of air handling systems etc;*
> *If the problem is not solved at this stage it may be necessary to engage specialist assistance to perform analysis of air pollutants and psychosocial factors.*

> *It is important that the occupants be kept informed promptly of the result of the investigations and action taken at each stage of investigation.*[161]

Mr Brown, of the CSIRO, suggested a similar approach:

> **Mr BROWN:** When I wrote the state of the environment report, we gave a scheme by which we think buildings should be investigated and this involves a systematic process. The first step is to actually get the plans of the building and have a walk-through inspection, look at the building to see if there is anything obviously wrong with the way the building has been operated or maintained, and things that are happening in the building. Some very obvious things can go wrong in a building and it is possible to exclude some of the building-related illness effects at that stage. After that is done, one needs to look at whether the building is operated at the appropriate ventilation rate.
>
> There are ventilation rate standards. Is the building been operated in accordance with the standard? Are there possible reasons why air may not be distributed uniformly in the building? There might be some dead corners and those things need to be checked. If those problems or faults are identified in that process, they can be remedied to see whether the people who are in the building improve in relation to the effects that they have been experiencing. If the effects are not remedied, probably the next step is to begin looking at levels of pollutants in the building. What I typically do is look at the pollutants that may be related to sources that we know emit specific pollutants in a building. For example, if there are a lot of particle board products, we will certainly look into formaldehyde. If a building has an unflued gas heater, we would certainly be looking at nitrogen dioxide.
>
> We look at things that we know affect people's health and how they feel and we try to determine whether there are levels above exposure goals in those buildings. If there are, then we obviously need to control that source. If that improves the occupants' health history, you know that you may have solved the problem. But it has to be a systematic and stepwise approach and I think it needs quite a lot of detailed investigation. That is how we try to determine whether there are faults in the building and find out if remedying those faults fixes the problem. There is no guarantee—such as the north-eastern office will be where the problems are because there is a lot of glare from the sky because of the windows. That will cause people a problem for their work and for their comfort, and they may think that that is a sick building type of effect because it causes a headache and non-specific health effects.[162]

In the United States the EPA and the National Institute for Occupational Health and Safety have produced a guide for building owners and managers. It identifies ways to reduce potential indoor air quality problems and how to respond when problems occur.[163]

Other measures can be taken to ensure that indoor air quality levels do not deteriorate:

- Air conditioning systems should be operated and maintained in a clean condition in accordance with the manufacturer's instructions.
- Ensure that fresh air is being circulated by avoiding the accumulation of office paraphernalia around air vents, louvres etc.

[161] D Rowe, Submission to the Inquiry, No 9.
[162] Transcript of Evidence p3.
[163] Building Science Forum of Australia, NSW Division, op. cit. p9.

- Expel pollutants accumulated during off-hours (especially weekends and other extended unoccupied periods) by early morning purging.
- Determine the impact of new activities and occupancy loads when making significant changes to the use of a space or building.
- Monitor indoor air quality at regular intervals and keep records.
- Executed drawings and instructions for operation and maintenance of the air conditioning and ventilation systems should be stored on site for the guidance of maintenance technicians.
- Ensure proper maintenance of the HVAC system by competent, well-trained personnel. Records control settings established during commissioning should be made available for technicians' reference.
- Cleaning fluids and particularly pesticides should be carefully selected for safe use in occupied space.
- Care should be taken to avoid the accumulation of moisture in occupied space and within air conditioning equipment. Such moisture can encourage microbiological organisms.
- Ensure a timely response by management to occupant complaints (dissatisfaction escalates when complaints are ignored).
- Consider converting a building to hybrid or natural ventilation. Conversion to hybrid or natural ventilation depends on cost, and would be more feasible for some buildings than for others. For instance it would be more feasible in buildings with openable windows and separate offices. (Conversion to hybrid ventilation was successfully undertaken at the Wilkinson Building at Sydney University, which the Committee inspected. Similarly, the Tillman Park Childcare Centre at Sydenham which the Committee visited was rebuilt with the emphasis on natural ventilation, natural lighting and even, as far as possible, natural noise impact amelioration (the centre is under the flight path).
- Install individual climate control systems wherever possible.
- Adapt design to maximise use of daylight.
- Retrofit sun control devices to minimise excessive direct sunlight and glare.
- Install a ducted vacuum cleaning system.
- Convert unflued gas heaters to flued gas heaters or install carbon monoxide monitors.
- Locally exhaust high pollutant sources such as photocopy rooms and kitchens (S9)

With particular regard to HVAC systems, action could include:

- audit the HVAC system to ensure correct settings and operation. Make necessary changes
- Check that air intake duct position is away from pollution sources (cars etc.)
- install high efficient air filters
- Ensure good air movement
- Ensure proper zoning of air conditioned areas
- Locally exhaust high pollutant sources such as photocopy rooms and kitchens

In existing buildings the responsibility for indoor environment falls to both the owner and the tenant (S9). Those responsibilities can be summarised as follows:

Building Owner:

- General good housekeeping, maintaining cleanliness in common areas and especially in plant rooms
- Ensure cleaning methods and agents that do not add to the pollution load in the air;
- Maintain air handling systems in clean and hygienic condition (eg avoidance of stagnant pools of water in plant spaces and particularly inside air handling systems)
- Careful management of the use of pesticides
- Maintenance of temperature settings within comfortable limits

Tenant:

- Materials used in internal fitout (with implications for indoor pollutants)
- Impact on HVAC systems of internal layout (obstructing vents; restricting ventilation flow etc)
- Cleaning (use of non toxic cleaners)

The DPWS advised the Committee in evidence that it can't force lessors to provide IAQ reports. However, the Government is a major presence in the rental property market in Sydney and regional New South Wales. The DPWS is the Government's strategic adviser and expert in this area and has argued for a whole of government approach to the strategic aspects of managing accommodation in order to bring this market power to bear for the benefit of the taxpayer (through lower rents and better lease arrangements, for example).

Others, however, have pointed out that market forces could eventually force building owners to consider IAQ issues. For example, with workers spending so much time in offices these days, tenant dissatisfaction with poor IAQ could limit the building owners ability to maintain tenants.[164]

Comment

In chapters two and three, the Committee outlined many of the problems associated with poor IAQ and SBS. What the Committee found was considerable health impacts with significant cost implications, both in health terms and lost productivity. Estimates are in the order of millions and even billions of dollars annually.

These obviously relate to existing buildings and demand action.

So while the Committee has focused in the preceding sections on preventing IAQ in new buildings, it is imperative to deal with IAQ and SBS problems in existing buildings are remedied.

The Committee had identified a number of strategies.

[164] Ibid p23.

There is an obligation, a duty of care, on the part of those responsible for buildings to ensure they operate properly.

It is unacceptable to rely on WorkCover/OH&S remedies for these problems, although these legislative recourses need to remain in place as a last resort. Much more preferable are the development of building codes, codes of practice, and agreements as part of lease negotiations.

Action can be taken in a number of distinct areas. In summary it is essential to reduce pollutant sources, make sure HVAC systems are operating properly, ensure that building cleaning procedures are not adversely affecting IAQ, and that procedures are in place to deal with concerns raised by occupants.

The DPWS model developed for the Crown Property Portfolio provides a good template addressing the problems in existing buildings.

Not only is the department the Government's building and construction expert, but it is also the Government's strategic office accommodation manager. It is therefore well placed to develop ways to utilise the Government's considerable market power to develop innovative approaches to improving the IAQ in office buildings.

The commercial imperatives of maintaining high occupancy rates should be used to ensure that IAQ is maintained at healthy levels. The Government has considerable clout in the office accommodation market place and avenues to exploit this power should be investigated. For example, the Committee is of the view that some form of comparing IAQ of buildings should be developed.

One of the critical factors in SBS is the psychosocial aspect. Occupants respond to problems or perceived problems on a very individual, psychological level. When concerns are raised by occupants about that operation the concerns need to be carefully considered.

Building managers and employers must careful consideration to concerns raised by occupants and have procedures in place to deal with these concerns. The Committee has reproduced some suggested procedures in this report.

Maintenance, particularly relating to HVAC systems, is critical. Poorly installed and improperly maintained HVAC systems can be a major source of indoor pollutants. It is vital to take all action to prevent the microbiological material being introduced into HVAC systems. Ways need to be developed to ensure internal fitouts do not reduce the optimal operation of HVAC systems.

Fitouts and other activities need to carried without introducing further pollutants to the indoor environment.

This is particularly relevant to cleaning of buildings, where techniques should ensure that offices are properly cleaned and that toxic cleaning agents are not used.

New products are being developed which no only address this issue but provided considerable financial savings by improving the energy efficiency of HVAC systems. They should be given careful consideration as part of developing strategies to improve IAQ.

RECOMMENDATION TWENTY-ONE

THAT a "compliance schedule" for mechanical ventilation and air-conditioning systems be included in the Building Code of Australia to ensure the systems are fit for health. (Such an approach was included in the New Zealand 1992 Building Regulations).

RECOMMENDATION TWENTY-TWO

THAT the HVAC systems in buildings be monitored on an annual basis to ensure compliance with the "compliance schedule" recommended above.

RECOMMENDATION TWENTY-THREE

THAT HVAC "compliance" requirements include techniques which ensure the control of microbiological material (such as slime) and fungi in the HVAC systems.

RECOMMENDATION TWENTY-FOUR

THAT the development of a graded building rating system (similar to the energy system on appliances) be investigated which would enable potential tenants and users to compare buildings.

RECOMMENDATION TWENTY-FIVE

THAT quantified conditions relating to air quality and thermal comfort be negotiated and documented in the contract as part of lease negotiations.

RECOMMENDATION TWENTY-SIX

THAT cleaning protocols or standards need to be reviewed or established to guarantee that cleaning is carried out for the purpose of protecting health (and not just for appearance). For example, the process must ensure the proper cleaning of carpets to remove dust mites and must avoid the use of hazardous cleaning agents. Realistic timeframes for cleaning contractors to properly clean buildings need to be ensured.

RECOMMENDATION TWENTY-SEVEN

THAT codes or guidelines be developed to encourage office fitouts to use non polluting materials and not to impact upon the operation of HVAC systems.

4.7 Education

The "Indoor Air Quality" report (State of the Environment p46) illustrates the value of public education in improving IAQ and SBS:

> Public education is an important tool for improving indoor air quality, especially in residences. It should be based on information derived from research findings in Australia or overseas that demonstrate where indoor air quality may occur, their causes and how to remedy

the problems. This will be necessary in order to avoid unnecessary (and wasteful) actions by the public in the complex indoor air quality scenario.

Examples of previous education campaigns related to the built environment include:

- An 8-page booklet, 'Reducing indoor air pollution', by the California Environmental Protection Agency (headings were: 'Evaluating the risk', 'What is indoor air pollution?')
- An educational campaign over two years from 1986 by the Commonwealth Department of Health. Over 60,000 copies of two documents were circulated. These were titled 'How healthy is the air in your home?' and 'Pollution – is your home safe?' Also, a video, 'Indoor Air Pollution', was made by Film Australia (video no. 86157) and was circulated to schools and doctors' surgeries. While the campaign and its products were immensely popular, no subsequent actions have been taken (L. Heiskanen, Deputy Director, Environmental Health, Commonwealth Department of Human Services and Health);
- A 1989 brochure from the State Pollution Control Commission titled 'How clean is the air in your home?' (headings were: 'Indoor air pollution', 'Sources', 'Which pollutants are common in Australia', 'How to tell if you're being affected', 'How to improve the air quality in your home');
- A 1994 brochure titled 'Reducing allergens which can cause asthma in your home' and 'Specifications for an asthma friendly house' from the Asthma Foundation of Victoria (Headings were: 'Major allergens', 'Choosing furnishings', 'How can the design of your home affect asthma?', 'External environment')
- Information sheets (1-2 pages) produced by the CSIRO Division of Building, Condensation in houses, 'Hints on curing a smoking fireplace', 'Improving sub-floor ventilation', 'Prevention and control of termite attack', 'Static electricity in buildings', 'How safe is CCA–treated timber?').
- The CSIRO publishes information sheets (1 - 2 pages). Examples are; Asbestos in the home, Improving home acoustics, Condensation in houses.

Comment
Education programs on SBS and IAQ be implemented to raise awareness across all sectors of the community. One way of doing this is by including it with the Green offices initiative. Other programs could be directed at residents.

Possible areas where education programs could be developed are:

- **Green Offices initiative;**
- **Information booklet for the public**
- **Resource information for architects, designers, owners, managers and maintenance staff, for example**
    - **DPWS to disseminate examples of leading environmental design for schools and other buildings for the benefit of the design and building industry. This could be done in collaboration with Royal Australian Institute of Architects**

RECOMMENDATION TWENTY-EIGHT

THAT education programs on SBS and IAQ be implemented to raise awareness across all sectors of the community. Specific areas for action would be:

- **Green Offices initiative;**
- **Information booklet for the public**
- **Resource information for architects, designers, owners, managers and maintenance staff, for example:**

-DPWS to disseminate examples of leading environmental design for schools and other buildings for the benefit of the design and building industry. This could be done in collaboration with Royal Australian Institute of Architects