Bactigas™, the Unique Australian Natural Germicide, Improves Indoor Air Quality.

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Summary
It is recognised that factors in buildings such as crowding and recirculated ventilated air can promote the spread of airborne pathogens emitted by occupants. Air conditioning system components such as cooling towers, air chillers and humidifiers and dehumidifiers can support the growth of fungi and bacteria. A sizeable proportion of the population is, or is capable of being, sensitised over a lifetime to these forms of biological air contaminants. The combined effect of all the biological air contaminants in indoor air is thought to account for a substantial proportion of absenteeism in the workplaces. By reducing biological air contaminants indoors, acute infections and allergic episodes can be significantly reduced (Vale, 1991).

The best approach to microbial control in air conditioning systems is to employ a regular maintenance program. Air-conditioning duct cleaning is an expensive exercise and most systems are not designed for cleaning.

BOC Gases has developed the Healthizone™ treatment which, as part of the regular maintenance programme, will assist in the control and prevention of harmful micro-organisms associated with an air conditioned environment. Bactigas™, a proven disinfectant containing natural Australian Tea Tree Oil as its active ingredient, is automatically injected into the ducting as a high pressure 'space spray' and is able to effectively penetrate through the duct work system.

Background
The need for sanitisation has been an issue from pre-historic times. The Hebrews, Greeks and Romans burnt aromatic woods in the streets to ward off plague and leprosy (Block 1977). Homer recommended growing a bay tree near the home and other suggestions were the burning of cedar woods to ward off plague (Radford 1961)

In recent years there has been a worldwide interest in the use of natural medicinal products, essential oils and other botanicals in response to the ever increasing incidence of allergic reactions, adverse side effects and the build up of resistance to synthetic disinfectants, germicides and antibiotics.

Tea Tree oil - Australia's Natural Germicide
The germicidal essential oil of the native Australian tea tree (*Melaleuca alternifolia*) which is indigenous to only one area in the world - the north-east coast of NSW, Australia, was first produced by distillation in 1925 (Penfold 1925). The natural habitat of *Melaleuca alternifolia* is the swampy low lying land of around the Clarence and Richmond River system. The popular name "Tea Tree" was first reported in Captain Cook's account of his second voyage entitled "A Voyage Towards the South Pole" in 1777 also the early settlers sometimes used the leaves as a bush substitute for tea

(Goldsbrough 1939). It has been said that the medicinal properties of Tea Tree oil were known to the Bundajalung Aborigines of Northern NSW. Stories are told of the "healing" properties of crushed Tea Tree leaves and the waters of lagoons into which Tea Tree leaves has fallen and decayed for hundred of years.

The pale yellow volatile Tea Tree oil is obtained by the steam distillation of the foliage and terminal branches of *Melaleuca alternifolia*. The major constituents of the oil is ~40% terpinen-4-ol, ~15% γ-terpinene, ~7% α-terpinene, ~6% α-terpineol and ~4% 1,8cineole. For many years Tea Tree oil was produced from trees harvested from bush stands of *Melaleuca alternifolia* but the industry has now established large scale commercial plantations around Lismore, NSW (Area under plantation 3,000 hectares; 70 million trees). Commercial quantities of high quality oil are being produced (~200,000 kg pa) with further intensive plantations development in progress and increased production capacity scheduled.

Biological testing showed high bactericidal activity against *Salmonella typhi* (Penfold and Grant, 1925). The minimum inhibitory concentration of Tea Tree oil is less than 1% against most gram positive bacteria (eg *Staphylococcus aureus*), gram negative bacteria (eg *Legionella spp*) and fungi (eg *Candida albicans*). Tea Tree oil has passed all standard preservative challenge test ie United States Pharmacopoeia (XX), British Pharmacopoeia (1980) and the NSW Health Department Therapeutic Goods Act (TGA) test.

The antimicrobial and preservative properties of Tea Tree oil and its non irritant nature suggest numerous commercial applications. Tea Tree oil is now accepted as a "medicine chest in a bottle" for the treatment of cuts, wounds, infections, minor skin disorders and a useful oil for Aromatherapists to incorporate into massage and bath oils. The oil has been marketed in a small way for many years. In health care products the initial enthusiasm waned with the advent of antibiotics. An increasing trend towards totally natural remedies has injected renewed vitality into the production of the oil which is now being incorporated into a wide range of health care products in Australia and overseas (Altman, 1988)

A world class research facility (Australian Tea Tree Oil Research Institute Limited - ATTORI) is being established at the Southern Cross University in Lismore for the specific purpose of carrying out research into the action and application of Main Camp Pharmaceutical Grade Tea Tree Oil.

The Value of Clean Air

One of the most common complaints raised by office workers concerns ventilation and air conditioning. In Australia typical absenteeism rates run at ~7% (NSW Chamber of Commerce), and no less than 40% of all absenteeism is estimated to be due to upper respiratory tract infections. The term Building Related Illness (BRI) describes illnesses which are caused by microbial contaminants in a building (Morey, 1988). The World Health Organisation's working group of experts on indoor air quality report that biological air contaminants in indoor air account for a substantial proportion of absenteeism and reduced worker efficiency in the workplace (Seuss, 1989). Lost productivity costs can be very high.

There is little litigation or legislation concerning indoor air quality, although numerous standards have been produced. This does not mean that the building owners, managers, or maintenance contractors are immune to being held legally responsible for problems (Carney, 1990). There have been successful prosecutions overseas and with the increasing instances of illnesses identified with air conditioning systems it is prudent to avoid legal proceedings by taking all available precautions (Greenwood, 1989).

Microorganisms are found everywhere. Their only requirements for multiplication are moisture and some nutrients. Often, enough nutrients can be absorbed from the air to allow growth, provided adequate moisture is available. Apart from outdoor sources there are also sources of contamination from within a building. Occupants release microbes into the air and the return air draws back microbial contamination to the air handling unit.

Bacteria causes diseases such as Legionellosis and various respiratory tract infections. They may also cause off -odours, which can circulate through the system. Bacteria can be controlled by maintenance, but the effectiveness of applied methods varies with different applications. Fungi causes musty odours and can generally detract from the appearance of a system. they are capable of causing skin infections and hypersensitivity reactions. They are common contaminants of air ducts in area of high humidity or periodic condensation collection (Shelley, 1990).

Micro-organisms taken in through the fresh air intake can also contaminate the duct work. A common cause of Legionnaires' disease outbreaks is when minute "respirable" water droplets containing *Legionella pneumophila* bacteria from cooling towers pass into a building through the fresh air intake. The notorious Legionnaire's disease got it name after 182 people attending the American Legion's annual convention at the Bellevue Stratford Hotel in Philadelphia, USA in 1976 were suddenly and mysteriously stricken by a flu-type illness. Twenty nine of those people died (the cause of the disease was not found until much later. The owner did not change the filter of the air conditioning but took the ultimate solution - he demolished the hotel). While the worst recorded case in Staffordshire, UK resulted in the loss of 37 lives the numbers generally are low and rarely pose a major threat to the community (Laurence, 1986)

Micro-organisms cause ill-health from contamination of the air, principally by two mechanisms: sensitivity or allergy, and infection. Many asthmatics have established allergies to moulds and other microbial irritants and exposure to these can produce an asthma attack.

An Ozone Friendly Solution

In response to the initial CFC ozone depletion publication (Rowland and Molina, 1974) BOC Gases conducted research into alternative aerosol propellants for space spray formulations. The project focused on liquefied gases and resulted in an international patent (Ryan and others, 1978) using carbon dioxide as a solvent / propellant system for dispensing chemicals. The unique features include non-flammability, ultra-fine particle size, ease of automation and sized for commercial needs (31kg and 6 kg cylinders). Particle size determinations found the droplets produced are in the range of 2μ to 20μ (Slater and others 1981). Over 2 billion 20μ

droplets are formed when spraying 1 gram of chemical and these droplets remain suspended in air for ~2 hours. This aerosol applications allows accurate and optimum dosage of various active ingredients including the natural antiseptic and fungicide, Tea Tree oil. The natural germicide product is marketed as Bactigas™ by BOC Gases Australia and it composition is 3% natural germicide concentrate and 97% liquid carbon dioxide. The formulation was optimised by maximising antimicrobial activity of the concentrate as measured by the British Pharmacopoeia Antimicrobial Test (BP 1982 Appendix XVC) against:

i.	*Staphylococcus aureus*	bacteria
ii.	*Pseudomonas aeruginosa*	bacteria
iii.	*Candida albicans*	yeast
iv.	*Aspergillus niger*	mould

The Bactigas™ concentrate achieved an **immediate** microbial count reductions of:
- 10^7 in bacteria compared to the required reduction of 10^3 over 6 hours
- 10^4 in yeast compared to the required reduction of 10^2 over 7 days
- 10^3 in mould compared to the required reduction of 10^2 over 7 days.

International patents have been granted for the use of Bactigas™ in the treatment of air conditioning systems. This patent allowed for the development of the BOC Gases Healthizone™ programme which focuses on the goal of clean, healthy working environment and includes the installation of automatic Bactigas™ dispensing and air sampling systems

The Healthizone™ Treatment

In the patented Healthizone™ treatment (Ryan and Vale, 1989), Bactigas™ is automatically injected into the ducting as a 'space-spray' and relies on compressed carbon dioxide to atomise the germicide into micro-droplets, as small as bacteria themselves. Bactigas™ can be injected when the air conditioning is on or off and it has been shown that the germicide is able to effectively penetrate through the duct work system.

The Healthizone™ treatment is an integral part of the total air conditioning maintenance programme which assists in the control and prevention of bacteria and fungi in the air handling system. It is important the building managers continue with the cleaning and regular maintenance programme as recommended in AS3666-1989. The removal of undesirable material from the duct work on a regular basis is often expensive since most systems are not designed for this exercise.

Although it is not possible to state a definite cut-off point for what is a significant level of microbial contamination of air, some preliminary guidelines have been formulated. These are based on published literature and overseas standards which set action levels for bacteria and fungi at 1000 Colony Forming Units per cubic metre of air (Morey and others, 1984). Systems containing such levels should be given prompt attention to rectify the problem. It is possible that levels below these are unsatisfactory if, amongst the species isolated, some are known to cause illness. Then, even a low count is

unsatisfactory and steps need to be taken to reduce or eradicate the micro organisms (Miller and others, 1988).

Major hotels in Australia's humid north have installed the Healthizone™ treatment and make significant savings in maintenance cost. The build up of unsightly moulds in areas of high humidity not only cause damage to wallpaper, paintwork and furnishings but creates unpleasant odours and is a potential health risk.

Conclusion

The quality of air in buildings is a vital issue of the 90's, involving health, productivity and staff morale. Air handling systems have been found by researchers to contain high levels of micro-organisms capable of causing allergies and infections. To this end, BOC Gases has developed the Healthizone™ treatment which, as part of the regular maintenance programme, will assist in the control and prevention of harmful micro-organisms associated with an air conditioned environment.

Healthizone™ involves a total service of disinfection of air conditioning duct work utilising Bactigas™ and on-going maintenance of air quality. Bactigas™ is a proven disinfectant containing natural Australian Tea Tree Oil as its active ingredient.

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