VOCs are various chemical compounds that vaporise under normal indoor conditions. Inorganic pollutants are produced through various natural processes	Air Fresheners Perfumes Cosmetics & Toiletries Household Cleaners Laundry detergents and fabric softeners Cooking Clothing fabrics Shoes Scented candles, incense, oils Floor coverings, vinyl floors, carpets Paint Pesticides Varnish Newspapers/magazines Adhesives Furniture Dry cleaned clothing	WHO categories V(ery) VOC Boiling Range - <0-50 °C to 100 °C VOC Boiling Range 50-100 °C to 240-260 °C S(emi) VOC Boiling Range – 240-260 °C to 380-400 °C	Key Facts VOC levels are higher in new buildings than in old (3 times higher in buildings built after 1982 compared to those built before 1940). New furniture can DOUBLE VOC emissions Painting & decorating can TRIPLE VOC emissions Some VOCs can take up to 6 months to dissipate Accumulations on indoor air create viral/chemical soup which is inhaled by occupants. Acute (short term) health effects including eye, nose and throat irritation, headaches, migraines, nausea and dizziness, especially for sensitive individuals with asthma, allergies and children/elderly. Chronic (long term) effects include organ and central nervous system/brain damage (depression), various cancers and birth defects The dangers of VOCs are often ignored. For example, when a new baby is introduced into the home, parents often redecorate a bedroom with new furniture/furnishings, plastic changing mats, toys and scented products and windows will often be kept closed to retain heat thus exposing the new born child whose lungs are still developing, to high levels of VOCs. To help reduce VOC levels, all rooms within properties must be well ventilated

COMPOUND	COLOUR	TASTE	USES	ACUTE SYMPTOMS	CHRONIC SYMPTOMS
Acetone Derived from carbohydrate fermentation, alcohol oxidation. Naturally occurring in human body	Colourless	Sweet	Precursor to Polymers Nail Polish Removers Superglue Remover Glass/Porcelain Residue Remover Solvent / Paint/Adhesive Thinner Sanitary Cleaners Laser Printer Toner additive Food additive Food packaging Heavy Duty Degreaser	Eye/Nose/Throat irritation Skin/Mouth irritation & damage	Kidney, Liver damage Central nervous system damage Birth defects
Benzene Derived from fossil fuel burning (forest fires, volcanoes) and crude oil distillation	Colourless CARCINOGENIC	Sweet	Paint, Varnishes, Solvents, Detergents, Thinners, Inks, Rubbers, Pesticides, Dyes, Lubricants, Degreasing Products, Medicines (paracetamol). Dry Cleaning Petroleum Processing Rubber Tyre/Shoe Manufacturing Cigarette Smoke Car Exhaust Emissions Incense Burning Heating/Cooking Oil burning	Eye/Nose/Throat irritation Headaches Dizziness Nausea Reduced platelet production Bone marrow changes	Genetic damage Bone marrow depression Cancer Death

Butyl Acetate Derived from dissolving acetic acid and butanol in a sulfiric acid base. Naturally occurring in fruits (banana/apple)	Colourless	Fruity (Banana/Apple)	Solvents/Lacquers Adhesives/Hardeners Fruit flavourings Anticorrosive agents Sealing agents Putty, Cleaning agents Car Care products	Respiratory issues	Central nervous system damage
Dichlromethane Derived from methane/chlorine mix and naturally occurring	Colourless CARCINOGENIC Metabolised by human body to produce CO	Mild sweet	Solvent in paint stripper, degreaser/thinner and remover, pharmaceutical/film coating. Aerosol propellant	Eye/Nose/Throat irritation Dizziness Nausea Headaches	Memory loss Unconciousness Death Cancers (Liver/Lung)
Formaldehyde Naturally occurring (PCO of methane in atmosphere) and by plant/animal decomposition. Methanol oxidation with air using metal catalyst. Most common indoor VOC. By-product of smoking, wood burning stoves/fuel burning appliances. Recently redecorated/newly furnished homes are source of formaldehyde. High humidity and temperature will increase rate of release	Colourless CARCINOGENIC	Strong, Pungent (pickles)	Medicine (cholera prevention in food/water) Food preservation Anti-bacterial/vaccinations (polio, diphtheria, Hep A, influenza) and in many cosmetic products including shampoo, deodorant, toothpaste, makeup, soap, mouthwash, air fresheners, anti aging cream, tanning agents. Plastics industry (buttons, resins) Furniture/furnishings industry – resins, adhesives and paints Paper towels, printing inks, newspapers, magazines. Textile industry – wrinkle/colour run prevention Agriculture – seed treatment, insecticide, fungicide Glues/adhesives, paints, waterproof/greaseproof products, petrol stabiliser	Eye/Nose/Throat irritation Eye watering/blurred vision Sneezing, Coughing and nasal discharge. Tingling/Soreness in throat Allergic reaction to skin/respiratory system	Menstrual/thyroid irregularities Cognitive/memory/concentration issues Sleep disturbances Decreased lung function capacity (asthmatics especially) Pulmonary oedema (fluid accumulation) Pneumonia Death Swelling of skin/dermatitis/eczema Cancer
Ethylene Glycol Derived from treating ethylene iodide with silver acetate	Colourless	Odourless	Dynamite (first use) Transportation industry - convective heat transfer in engines, anti-freeze for engines, deicing fluid for windshields.	Eye and respiratory tract irritation	

			HVAC appliances Food and cosmetics (hygroscopic) Solvent (paints, grout, primer, sealant, floor polish, lacquer, shoe polish, dyes, inks. Wood rot/fungal treatments Precursor to polymers (polyester fibres, resins, soft drink bottles)		
Ehtylbenzene	Colourless	Petrol	Styrene production Solvent in paints, lacquers and varnishes. Asphalt constituent	Eye/Nose/Throat irritation	Fatigue, headache, drowsiness, staggering gait, lack of coordination. Kidney damage
Ethyl Acetate By product of fermentation in fruits/wines. Contributes toward perception of fruitiness in young wines	Colourless	Sweet, Fruity	Solvent – varnishes, paints, nail varnish remover, printing inks, synthetic rubber, vinyl resins, dry cleaning. Coffee decaffeination. Perfumes and flavourings (chewing gum)	Eye/Nose/Throat irritation, swelling, runny nose, redness, headaches, nausea, vomiting and sleepiness	Clouding of eyes Damage to lungs, heart, kidney and liver
Naphthalene Produced from coal tar or petroleum distillation or from wood, cigarette or car exhaust burning	White	Mothballs	Dyes, plasticisers for concrete, plasterboard ingredient, dispersant in synthetic and natural rubbers, tanning agents. Paints, insect/moth repellent, disinfectant, toilet deodoriser	Headaches, nausea, dizziness, vomiting, diarrhoea, malaise, confusion	Haemolytic Anaemia (reduced red blood cell lifespan from 120 days to about 5 days). Red blood cells carry oxygen around the body.
Nitrogen Dioxide 1% naturaly occurs (lightning). Produced by plants, soil and water. Decomposes in water to produce nitric acid and nitric oxide	Reddish Brown	Acrid, pungent, bitter	Vehicle emissions, gas stoves and unvented heaters (NO is produced by these combustion processes which combines with oxygen in the atmosphere to produce NO2) Manufacturing industries, food processing, bleaching flour, petrol and metal refining.	Respiratory issues (inflamed lining of lungs, reduced immunity to lung infections) Burning sensation in airways	Wheezing, coughing, colds, flu and bronchitis. Asthmatics, children and elderly and those with heart disease at most risk
Tetrachloroethylene	Colourless CARCINOGENIC	Sweet, Sharp	Solvent – Dry Cleaning/stain removal Paint removers/Adhesives Automotive /Metal working industry - Metal degreasing/cleaning	Eye/Nose/Throat irritation Dizziness, headache, sleepiness, confusion, nausea, difficulty in speaking and walking, unconsciousness and death	Depression of central nervous system Menstrual problems/spontaneous abortions Cancer

Toluene Produced from coal tar or petroleum distillation	Colourless	Sweet, Pungent	Common solvent uses in numerous products including adhesives, cleaners, polishes, paints, inks, thinners etc & starting material for dyes and explosives. Also used in production of nylons, plastics and medicines. Can be found in tobacco smoke.	Central nervous system – headaches, tiredness, confusion, nausea, dizziness, clumsiness, drowsiness, drunkenness	Kidney, central nervous system, liver, heart and brain damage. Problems with speech, vision, hearing, loss of muscle control, loss of memory/balance and reduced scores in psychological tests Damage to foetus
Trichloroethylene	Colourless CARCINOGENIC	Sweet	Common solvent – grease remover. Ingredient in adhesives, lubricants, paints, varnishes, strippers, carpet shampoos, water proofing agents. Textiles – scourer for cotton, wool etc to remove oils, dyes/finishings.	Central nervous system – headaches, tiredness, confusion, nausea, dizziness, clumsiness, drowsiness, drunkenness Rapid breathing at higher levels Irreversible cardiac issues, nerve and liver damage and death and very high levels	Nausea, fatty food intolerance, respiratory irritation, kidney toxicity, immune system depression. Alcohol consumption increases toxicity as "degreaser's flush" – red blothes on skin Amyotrophic lateral schlerosis (form of motor neurone disease similar to Parkinson's) reported in some Gulf War veterans (was used as a cleaning solvent)
Xylene	Colourless	Sweet, Aromatic	Solvent in paints, thinners, coatings, varnishes, blended in petrol. Organic chemical production – polyester fibres for carpets, clothing and to make dyes and insecticides. Sterilising catgut and microscopy. Cleaning agent – steel/silicone chips	Eye/Nose/Throat irritation Headaches, lack of muscle coordination, dizziness, confusion and alterations in body balance.	

INORGANIC POLLUTANTS

Carbon Monoxide Formed by burning wood, coal and gas Reacts in body to produce carbonmonoxyhemoglobin which inhibits oxygen intake	Colourless	Odourless	Unvented gas heaters, eaking chimneys and furnaces, vehicle emissions, generators/petrol powered equipment and tobacco smoke	Fatigue at low levels Angina, impaired vision and reduced brain function at moderate levels. Headaches, dizziness, confusion, nausea, flu like symptons at higher levels. FATAL is high concentrations	FATAL
Ozone	Pale Blue	Sharp, like chlorine, smell after a	Some (older) air cleaning devices including Ionizers and Ozone	Respiratory inflammation, reduced lung function.	

Occurs naturally in upper atmosphere (nitrogen oxides and VOCs and UV sunlight)		thunderstorm	generators. Printers and photo copiers also emit ozone. Used as a disinfectant in water and a bleaching agent in the textile industry	Chest pain, coughing, nausea, pulmonary congestion. Worst for children, elderly and those with asthma and other breathing conditions	
Methylene Chloride Produced by chlorinating methane at high temperature. Affects brain the same way alcohol does. Breaks down into CO in human body	Colourless	Sweet	Solvent and water repellent Tea/coffee decaffeinator	Eye/Nose/Throat irritation Dizziness, nausea, tingling/numbness in fingers/toes.	Fatigue, sleepiness, poor coordination, loss of short term memory, depression, anxiety and irritability. People with heart and lung conditions, smokers, overweight or pregnant and those with exposure to CO should limit exposure to methylene chloride
Sulphur Dioxide Produced by active volcanoes and forest fires and by burning fossil fuels	Colourless	Pungent, like burnt matches	Oil refineries, power stations Motor vehicles, domestic boilers and fires	Nose/throat irritation Nausea, vomiting, stomach pain and corrosive damage to airways and lungs at higher levels. Children, elderly and those with asthma and other breathing conditions are most at risk	

Particulate matter (PM) is the name for a wide range of particles that are small enough to be carried by the air and can be breathed by people.	PMs are divided into 2 principal groups: INHALABLE – up to 100 microns and RESPIRABLE – up to 10 microns	Key Facts Indoor PM comprises biological pollens and fungal spores, liquids in aerosols and solid particles from carbon (soot and cigarette smoke). Dust particules may contain lead, pesticide residues, radon and other toxic materials. Other particles may be irritants and carcinogens eg. Asbestos. Many studies show a link between PM pollution and cardiovascular disease, respiratory disease and cancer. Exposure to PM <2.5 leads to high plaque deposits in arteries causing vascular inflammation and atherosclerosis (hardening of arteries) and causing heart attacks plus lung diseases such as emphysema and lung cancer. Health effects can include coughing, wheezing, shortness of breath, aggravated asthma, lung damage (decreased lung function and lifelong respiratory disease) and premature death in those with such conditions. The finer/smallest particles represent the greatest threat to human health as they can travel deepest into the lungs. Health effects include the toxic effects of absorption of the dust into the blood (lead, cadmium, zinc poisoning etc), allergic and hypersensitivity effects, bacterial and fungal infections, fibrosis (asbestos, quartz), cancer, irritation of mucous membranes and long term effects on lung function (worst in sensitive people – asthma/respiratory conditions, children, elderly etc) Working/living near a busy road can increase indoor levels of PM2.5 from vehicle exhausts Currently, indoor air is not monitored in the same way external air is monitored. Black Bear will revolutionise indoor air and PM measurement and monitoring

MATERIAL	SOURCES	COMPOSITION	HEALTH EFFECTS
Asbestos Natural mineral rock. V durable and resistant to fire. Presents health risk when fibres become airborne and are inhaled First documented death in 1906. First asbestosis case in 1924.	Can still be found in a range of materials used in building industry until 1999 including: Cement products Pipe/Boiler lagging Textured coatings ie Artex Floor/ceiling tiles Bath panels/toilet seat/cisterns Partition walls Panels on fire doors Asbestos water tank Textiles Sprayed coatings Insulating board Loose fill insulation Guttering Soffits Roofing felt Cement panels	Types: Serpentine (Layered structure/curly fibres) Chrysotile. Most common and most dangerous. Accounts for 90% of all commercially used asbestos in the world. Fibres are long white and curly. Amphibole (Chain structure of sharp/straight fibres) Amosite (used in insulation products), Crocidolite, Tremolite, Anthophyllite and Actinolite)	Health effects: Mesothelioma. Cancer that affects lining of lungs and lower digestive tract. Almost always FATAL. Very progressive cancer. Asbestos related lung cancer. Same as smoking related cancer. It is estimated there is one lung cancer for every mesothelioma death. Asbestosis. Serious scarring of the lungs. Progressive shortness of breath. Can be FATAL if severe. Asbestos is the biggest occupational disease risk to construction workers. In 2005 it accounted for more than 2/3 of the total cancer deaths in the industry.
Man Made Mineral Fibres (MMMF) Widely used as thermal	Mineral wools – glass wool, rock wool, slag wool (thermal/acoustic insulation) Continuous filament –	MMMF generally larger than asbestos fibres. Defined as fibres longer than 5 microns, narrower than 3 microns with length/width ratio of > 3.1.	Long term effects: Respiratory system (asthma/bronchitis) Decreases in lung function Glass wool may cause respiratory cancer.

and acoustic insulation	glass/textile fibre Refractory fibres – ceramic/special purpose fibres (high temperature insulation)	Should not be considered as safe despite size (usually retained in upper respiratory tract/eliminated by alveolar macrophages). No information available on short term effects in humans.	Refractory Ceramic Fibres are potential carcinogen.
Nanoparticles	Wide range of appliances in science, technology and medicine (scratchproof eyeglasses, light weight sports equipment (tennis rackets), sunscreens, ceramic coatings for solar cells etc.	Particles between 1-100 nanometres in size. 100 nanometres = 0.1 micron or 1/billionth metre. Particles smaller than 100 nanometres are known to pass through cell membranes and migrate to other organs including the brain. Diesel PM is in the size range of 100 nanometres.	Escape alveolar macrophage surveillance due to size. Brain damage similar to Alzheimer's.
Radon Colourless, odourless Produced underground by radioactive decay of thorium and uranium into polonium-218 and eventually into stable lead. First discovered in homes in 1984 by US nuclear plant worker who was setting off radiation alarms despite being decontaminated. Radiation readings were 1,100 higher than acceptable levels	Air pressure inside buildings tends to be lower than outside pressure. Radon infiltrates cracks in building foundations, walls, cavities etc. Average radon in most homes is 20 Bq/m3. Half life of 3.8 days	Radon is a gas and is easily inhaled where its continual decay process continues (iemitting alpha particles as radiation) causing localised damage to the lung tissue. UK Radon Council recommends floor openings are sealed and whole house positive input/pressure ventilation to help manage indoor radon levels.	Lung cancer. Radon causes >1,100 deaths from lung cancer each year in the UK. Half of these deaths occur among the quarter of the population who are current smokers.

Biological contaminants include mould, bacteria, viruses, pollen, dust mites and pet saliva, faeces and dander.	Key Facts Produced by living things. Found in areas that provide food and moisture such as damp, wet, humid areas. Many small enough to be inhaled. Some cause allergic reactions. Bacteria and viruses can cause infections. Common symptons include coughing, wheezing, allergic reactions, eye, nose and throat irritation and headaches. Worst for those living in high humidity and worst for asthma sufferers.

CONTAMINANT	SOURCES	COMPOSITION	HEALTH EFFECTS
Fungi and Mould Thrive in damp, humid environments. Approx 1.5 million species of fungi. Approx 1,000 species have evolved within the built environment. Fungi can be pathogens and cause infections in sensitive people	Fungi live by decomposing and absorbing organic material. Ideal conditions >70% RH and temp range -10C-65C Typical air sample may contain 200,000 spores/m3. MOST FUNDAMENTAL CONTROL MEASURE IS MOISTURE CONTROL, PREVENTING HIGH HUMIDITY AND CONDENSATION THROUGH GOOD WHOLE HOUSE VENTILATION. ALSO VENTILATION SYSTEM DUCTS FILTERS SHOULD BE CLEANED RGULARLY. HEPA FILTERS SHOULD BE USED.	Types: Toxic or Allergenic Moulds Moulds from Dust	Health effects: Fungi produce mycotoxins which can cause liver, kidney damage and respiratory reactions 30% of people show allergic reactions to fungal spores. Symptoms include wheezing, coughing, shortness of breath and immunosuppressant disorders.
Mould & Mildew Mould is a fungus. Needs water, oxygen, warm temperature and organic material 2 types - Powdery (starts whitish in colour – looks like talcum powder – turns to yellowish brown then black) Downy (yellow spots	Can grow on wood, drywall (plaster/gypsum), upholstery, fabric/shoes, wallpaper, drapery, ceiling tiles, carpets. Can digest paints and adhesives. Cannot digest glass or metal but can live on such surfaces if dust and debris is present Mildew only grows on plants. Not to be confused with mould that grows around window frames or in bathrooms/areas of high humidity.	Mould makes spores which are carried on the air or by water. Visible mould growth can be black, grey-brown, grey-green, white, orange, pink, purple in colour and appear as spots or threads. Colour is influenced by nutrient source and age of colony. Not all mould growth is visible (can occur behind wallpaper/within walls) but smell is v pungent and noticeable	Health effects: Allergic reactions and respiratory problems dues to mycotoxins produced by the mould. Approx 250 types of known mycotoxin.

turns to brown)			
Bacteria & Viruses Bacteria usually smaller than fungi. Single celled micro-organisms. Viruses are smallest type of microbe. 100 times smaller than bacteria. Viruses cannot grow on their own and must enter/take over a cell to help them multiply	Ventilation duct dust can contain up to 50,000 bacteria per gram. Filters can contain up tp 6,700 bacteria per gram.	Legionellosis (diseases caused by legionella bacteria) becomes a health concern when it grows in man-made water systems. Thrives in 20C-50C range. Most common form of transmission is inhalation of contaminated airborne aerosols from showers and humidifiers. Viruses like flu are spread when infected people cough/sneeze and spray tiny droplets contaminated with the virus into the air/onto surfaces which are inhaled or touched and ingested by others. 3 categories of flu virus – A,B or C. A is the most common.	Health effects: Bacteria can cause many building related illnesses including Legionnaire's disease, allergic rhinitis, asthma and hypersensitivity reactions. Legionnaire's disease symptoms start with cough/fever, loss of appetite, headache, malaise, lethargy, muscle pain, diarrhoea and confusion. Progresses to rapidly fatal pneumonia (respiratory failure, shock and/or organ failure. Viruses like flu can lead to serious health problems like pneumonia or lung infections and can make conditions of diabetes and asthma worse.
Pollen Microscopic yellowish powder. Many pollens are allergens	Wind, birds, insects, other animals. Enters buildings through open windows and doors or on shoes/clothing/animals. GENERAL PREVENTATIVE ADVICE: KEEP WINDOWS/DOORS CLOSED. GOOD VENTILATION AND VACUUMING WITH HEPA FILTRATION	Can remain suspended in the air for hours More pollen released on hot dry days. Thunderstorms also increase effects of pollen due to humidity which suspends pollen in the atmosphere. 1 in 5 people in the UK suffer from hay fever and asthma	Health effects: Grass pollen most common hay fever trigger. 95% of people suffer this in the UK Symptoms include sneezing, watery eyes, nasal congestion, runny nose , itchy throat and cough. Hay fever, allergic rhinitis can develop and can aggravate asthma due to release of histamine.
Dust Mites Too small to be seen with naked eye. Approx 9 microns	13 species of dust mites. All have adapted to indoor environments. Ideal conditions – warm 21C. >70%RH. Found in bedding, carpets and fabric furnishings, stuffed toys and any environment that holds moisture and heat. Most dust mites live in bedrooms	Live on dead skin cells Average adult will shed 1.5 grams of skin per day which will feed 1 million dust mites	Health effects: Allergic reactions in asthmatics. Faecal matter known asthma attack trigger. Human body produces antibodies when faecal matter is breathed in and detected which results in sneezing, runny nose, itchy skin/eyes, scratchy throat and sinus pressure. Most severe reactions in asthmatics.

	GENERAL PREVENTATIVE ADVICE: GOOD VENTILATION/HUMIDITY CONTROL AND VACUUMING WITH HEPA FILTRATION		