Nuvap

INDOOR ENVIRONMENTAL FACTORS

WHITE PAPER

INDOOR POLLUTION

Understanding how to minimise health concerns and gain health benefits

People spend more then 90% of their time indoors. A good indoor environment is important, therefore it is crucial to know the health risks, how to prevent and how to remediate them.

The exposure to pollutants is proven to have an impact on people's health and increases considerably risk and burden of respiratory diseases, cardiovascular and neurodegenerative diseases, cancer.

The whole population is affected by those risks, although some groups are more sensitive (children, patients, pregnant women, elder people).

Many governmental programs are running in schools. Several programs have been promoted to improve the quality of workplaces, for its impact on cognitive functions.
Indoor Pollutants can be grouped in 3 main types: Physical, Chemical and Biological factors.

This white paper focuses on the main Physical and Chemical factors, that threaten the quality of indoor environments.
Furthermore, it includes some information about Moisture and Thermal Environment, since those factors have an impact on the presence and proliferation of pollutants.

PHYSICAL FACTORS

RADON

Definition:Radon is a naturally occurring radioactive gas. It comes from the natural (radioactive) breakdown of uranium in soil, rock and water and gets into the air

Sources: Radon can get into any type of building–homes, offices, and schools–close to radon sources and result in a high indoor radon level. Moreover it is possible for any granite sample to contain varying concentrations of naturally occurring radioactive elements that can emit radiation and produce radon gas.

Risks: Overall, radon is the second leading cause of lung cancer. Radon gas decays into radioactive particles that can get trapped in lungs. As they break down further, these particles release small bursts of energy. This can damage lung tissue and lead to lung cancer over the course of lifetime.

IONISING RADIATIONS

Definition:Ionising radiations are radiations having so much energy to knock electrons out of atoms.There are different types of Ionising Radiation: Alpha, Beta and Gamma.

Sources: Radioactive elements, cosmic radiation from space, and medical x-ray machines are sources of ionising radiation. Industries use radiation in a variety of ways. For example, industrial radiography uses x-rays to check for weak points in metal parts. Irradiators are used to kill bacteria and other pathogens in food and other items.

Risks: Ionising radiation affect the atoms in living things, so it poses a health risk by damaging tissue and DNA. I.e. if alpha-emitters are inhaled, the alpha particles can damage sensitive living tissue. Gamma rays can easily penetrate barriers that stop alpha and beta particles, such as skin and clothing.

Clean air is a basic requirement of life. The quality of air inside homes, offices, schools, day care centres, public buildings, health care facilities or other private and public buildings where people spend a large part of their life is an essential determinant of healthy life and people's well-being. Hazardous substances emitted from buildings, construction materials and indoor equipment or due to human activities indoors, such as combustion of fuels for cooking or heating, lead to a broad range of health problems and may even be fatal

(Source: WHO guidelines for indoor air quality: selected pollutants)

PHYSICAL FACTORS

NOISE

Definition: Sound becomes unwanted when it either interferes with normal activities such as sleeping, conversation, or disrupts or diminishes one's quality of life.

Sources: Most leading noise sources will fall into the following categories: road traffic, aircraft, railroads, construction, industry (fans, motors, and compressors), noise in buildings (plumbing, boilers, generators, air conditioners, and fans), consumer products and low noise emission products.

Risks: Problems related to noise include stress related illnesses, high blood pressure, speech interference, hearing loss, sleep disruption, and lost productivity. Noise Induced Hearing Loss (NIHL) is the most common and often discussed health effect.

EMF

Definition: Electromagnetic fields (EMF) are a combination of electric and magnetic fields of energy that surround any electrical device that is plugged in and turned on. EMF are called 'non-ionising radiation'.

Sources: EMFs are found near power lines and electronic devices. The fields from power lines and electrical devices have a much lower frequency than other types of EMF, such as microwaves or radio waves. The greater the distance between the individual and the source of EMF, the less the exposure is. The less time individuals spend near EMF, the lower their exposure is.

Risks: Many health outcomes ranging from reproductive defects to cardiovascular and neurodegenerative diseases have been examined, but the most consistent evidence to date concerns childhood leukaemia. Radio Frequency exposure is far higher for mobile phone users than for those living near cellular base stations.

High frequency (HF) is the designation for the range of radio frequency between 100kHz and 300GHz

Low frequency (LF) is the designation for frequencies in the range of 30–300 kHz.

CHEMICAL FACTORS

CARBON MONOXIDE

Definition: Carbon Monoxide is a colorless, odorless, and tasteless gas which results from combustion of fuels.

Sources: It is often associated with combustion heating devices (e.g. boilers, furnaces) and auto, truck, or bus exhaust from attached garages, nearby roads, or parking areas.

Risks: At moderate concentrations, angina, impaired vision, and reduced brain function may result. At higher concentrations, CO exposure can be fatal. The most common symptoms of CO poisoning are headache, dizziness, weakness, upset stomach, vomiting, chest pain, and confusion. CO symptoms are often described as "flu-like." People who are sleeping or drunk can die from CO poisoning before they have symptoms.

CARBON DIOXIDE

Definition: CO_2 is a colorless, odorless, and tasteless product of combustion.

Sources: Carbon dioxide (CO2) is the primary greenhouse gas emitted through human activities. All combustion processes and human metabolic processes are sources of CO_2. Concentrations of CO_2 from people are always present in all occupied buildings. When people breathe, they exhale carbon dioxide.

Risks: At concentrations normally found in buildings, CO_2 is not a health hazard. Carbon dioxide in its gas form is an asphyxiant.
Exposure to carbon dioxide can cause hyperventilation, dizziness, headache, sweating, fatigue, confusion, skin and eye burns, and ringing in the ears. High levels of CO_2 in working places are associated to lack of attention and low productivity.

It may come as a surprise to many of us that the air in an urban street with average traffic might actually be cleaner than the air in your living room. Recent studies indicate that some harmful air pollutants can exist in higher concentrations in indoor spaces than outdoors. In the past, indoor air pollution received significantly less attention than outdoor air pollution […] However, in recent years the threats posed by exposure to indoor air pollution have become more apparent

(Source: EEA - Indoor air quality)

CHEMICAL FACTORS

VOC

Definition: When discussing indoor environments, all organic chemical compounds that can volatilise under normal indoor atmospheric conditions of temperature and pressure are VOCs (Volatile Organic Compounds). Usually, VOCs don't include CO, CO_2, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions.

Sources: Indoors, VOCs are mostly released as gases into the air from certain solids or liquids, as paints, paint strippers and other solvents; wood preservatives; aerosol sprays; cleansers and disinfectants; moth repellents and air fresheners; stored fuels and automotive products; hobby supplies; dry-cleaned clothing; pesticide; building materials and furnishing; office equipment such as copiers and printers, correction fluids and carbonless copy paper; graphics and craft materials including glues and adhesives, permanent markers and photographic solutions.

Risks: Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors. Health effects may include: eye and respiratory tract irritation; headaches; dizziness; visual disorders and memory impairment.

FORMALDEHYDE

Definition: A colorless, flammable, water-soluble gas. Due to its wide use, it is frequently considered separately from other VOCs.

Sources: Materials containing formaldehyde include building materials, furnishing, and some consumer products. The primary way to be exposed to formaldehyde is by breathing air containing off-gassed formaldehyde. Formaldehyde is used as a tissue preservative in medical laboratories, as a preservative in some foods and as an antibacterial ingredient in cosmetics, household antiseptics, medicines, dishwashing liquids, fabric softeners, carpet cleaners, lacquers, and wood products. It is used as a preservative in some paints, paper coatings, in the permanent press coating on fabrics; in carpets; and in some foam insulation materials.
Formaldehyde is used industrially in the manufacturing of other chemicals, pesticides, fertilisers, latex rubber, photographic film, and preservatives; in glues and adhesives for pressed wood products such as particle board and plywood; in leather tanning; and as an industrial fungicide, germicide, and disinfectant.

Risks: Besides the annoyance, it also causes acute eye burning and irritates mucous membranes and the respiratory tract. EPA has determined formaldehyde to be a probable human carcinogen.

CHEMICAL FACTORS

METHANE

Definition: Methane (CH4) is a hydrocarbon that is a primary component of natural gas. Methane is also a greenhouse gas (GHG). It is a colorless, odorless, and extremely flammable gas that can be explosive when mixed with air.

Sources: Methane is emitted from a variety of anthropogenic (human-influenced) and natural sources. Anthropogenic emission sources include landfills, oil and natural gas systems, agricultural activities, coal mining, stationary and mobile combustion, wastewater treatment, and certain industrial processes. Another source of methane includes rice cultivation

Risks: Methane in its gas form is an asphyxiant, which in high concentrations may displace the oxygen supply needed for breathing, especially in confined spaces. Decreased oxygen can cause suffocation and loss of consciousness. It can also cause headache, dizziness, weakness, nausea, vomiting, and loss of coordination. Skin contact with liquid methane can cause frostbite. Methane is extremely flammable and can explode at concentrations between 5% (lower explosive limit) and 15% (upper explosive limit). These concentrations are much lower than the concentrations at which asphyxiant risk is significant.

DUST AND SMOKE

Definition: Particulate matter (also referred to as PM or particle pollution) is a complex mixture of solid and/or liquid particles suspended in air. These particles can vary in size, shape and composition. Particulate is classified into 3 size categories: Coarse particles (2.5 to 10 µm in diameter); Fine particles (2.5 µm or smaller) and Ultra Fine particles (0.1 µm or smaller).

Sources: Most PM particles form in the atmosphere as a result of chemical reactions between pollutants. Indoor PM levels are dependent on several factors including outdoor levels, infiltration, types of ventilation and filtration systems used, indoor sources, and personal activities of occupants. Indoor PM can be generated through cooking, combustion activities (including burning of candles, use of fireplaces, use of unvented space heaters, cigarette smoking) and can also be of biological origin. Particulate is also generated by chemical reactions between elements in the air and materials inside of buildings, and by printers.

Risks: Fine and ultra fine particles may be small enough to pass through the throat and nose and enter deeper into the lungs.
Scientific studies have linked PM exposure to a variety of health impacts, including eye, nose and throat irritation; aggravation of coronary and respiratory disease symptoms. Children and older adults may be at greater risk from PM exposure.

BASIC FACTORS

TEMPERATURE

Definition: Temperature is easily measured, but the thermal confort can be subjective.

Sources: Thermal confort can be influenced by several factors. Air Temperature is just one of them. Air speed, radiant temperature and relative humidity, as well as the individual metabolic rate, affect the perception of the environment temperature.

Risks: Thermal environment influences health and productivity. Inadequate temperature and humidity conditions affect indoor air quality. As temperature and relative humidity increase, so does the rate at which chemicals are released. Mold and dust mite populations also increase with humidity levels. In addition, people who are thermally uncomfortable may have a lower tolerance to pollution exposures.

MOISTURE

Definition: Indoor humidity should be kept always below 60% (ideally between 30 and 50%).

Sources: When excessive moisture accumulates in buildings or on building materials, mold growth will often occur, particularly if the moisture problem remains undiscovered or unaddressed. It is impossible to eliminate all mold and mold spores in the indoor environment. However, mold growth can be controlled indoors by controlling moisture indoors.

Risks: All molds have the potential to cause health effects. Molds can produce allergens that can trigger allergic reactions or even asthma attacks in people allergic to mold. Others are known to produce potent toxins and/or irritants. People with weakened immune systems (i.e., immune-compromised or immune-suppressed individuals) may be more vulnerable to infections by molds (as well as more vulnerable than healthy persons to mold toxins).

Sources

EPA (United States Environmental Protection Agency) - Online resources
EEA (European Environment Agency) - Online Resources
WHO (World Health Organisation) - WHO guidelines for indoor air quality: selected pollutants
ETUI (European Trade Union Institute) - Electromagnetic fields in working life. A guide to risk assessment

Nuvap

Nuvap is a pioneer in the management of indoor pollution and promotes people's health and the healthiness of built environment.

Nuvap solutions enable the monitoring, assessment and communication of indoor environmental quality in a simple and in-depth way, considering up to 26 environmental parameters, including many chemical and physical pollutants.

Nuvap's R&D efforts are focused on the detection and analysis of environmental data. The intellectual property is protected by international patents.

In 2017, Nuvap won the Edison 'Best Smart Home Technology' Pulse award and in 2019 it won the eHealth4all award, as the best prevention technology.

The company has an engineering lab in Pisa and offices in Milan.

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